# 5 Overview of the Cold War Years

## Postwar Air Force Aviation Construction Drivers

### *Demobilization and the Truman Years*

Japan's surrender had brought the Second World War to an abrupt end, and the Army Air Force concentrated on three basic activities as it entered the postwar world: demobilization, technological development, and the achievement of independent status. Immediately following the war in 1945, the Army Air Force entered into the same drawdown process that affected the other armed services. The force level in late 1945 was approximately two million personnel and 65,000 aircraft; by the end of 1946 the force had been reduced to 300,000 personnel and 24,000 aircraft. Maintenance staffs were reduced by 90 percent and aircraft mission availability had fallen from more than 50 to less than 20 percent. Army Air Force leaders had called for a postwar organization of 105 air groups but reduced that figure to 70 because of funding constraints. They finally received authorization for just 55 in December 1946, of which only two could be considered combat-ready.

MAJOR THEMES AND CONTEXTS

- SAC Bomber Facilities
- ADC Scramble Facilities
- Sustained Forces Doctrine
- SAC Dispersal Program
- Aircraft-Specific Construction

#### The Jet Age

At the same time the Army Air Force was undergoing this drastic reduction in size it was also experiencing a revolution in technology and design. Great strides had been made in aeronautics during the war, but the United States had focused much more on accelerated production than on new technologies.

During WWII, the last of the vintage biplanes, armed with machine guns, had been replaced by the all-metal monoplane with rapid-fire cannon and wing hard points to resist ground attack ordnance. These, in turn, were challenged by new jet aircraft in an increasingly complex environment that included airborne and ground control radar, electronic countermeasures, and guided missiles. While the United States had followed these developments, its own research efforts were

subordinated to accelerated production programs — wartime national policy had called for improvements to existing weapons more than the development of new ones.

After the war, American research and development began to catch up and, with the help of data captured from Germany on such subjects as jet engines and swept-back wings, the United States entered the jet age.

Research and development became one of the primary concerns in the downsized postwar Army Air Force because the nation would rely on technical air supremacy to ensure the national security. Only the highest quality, most advanced weapons would suffice, in this new age, to enable our reduced forces to cope with potential enemy aggression. A program of accelerated obsolescence was established, which dictated that a given piece of equipment must only be relied upon as a front-line weapon for a short span of years before being replaced by a more advanced design. The first operational American jet fighter — the P-80 (F-80 after 1947) Shooting Star — first entered service in 1946, and was quickly joined by the F-84 Thunderjet and F-86 Sabre Jet by 1950, all of which would see service in the coming conflict in the skies over Korea.[1]

### Birth of the U.S. Air Force

The idea of an independent, coequal Air Force was not a new one, of course, as members of the air services had consistently sought this status since as early as 1916. During WWII, the Army Air Forces had essentially acted as an independent service because it was the most convenient way to operate the massive wartime effort. This informal arrangement, secured by a presidential order made under the War Powers Act in 1940, was scheduled to end 6 months after war's end. Now a decision would have to be made on the future status of the Air Force. There was little doubt, really, that the Air Force would be granted independent status, given its performance in the war and President Truman's support for the change. Legislation was introduced in 1945 proposing a single Department of Defense (DoD) with three coequal services: the Army, the Navy, and the Air Force. The only real opposition came from the Navy: first, the Navy disliked its funding prospects in a new environment wherein the Secretary of the Navy was one of three defense secretaries (as opposed to being one of two, previously); second, it feared the loss of its time-honored status as the nation's first line of defense. After 2 years of wrangling, Truman's vision became reality in the National Security Act of 1947. It provided for a separate and coequal United States Air Force (USAF) under the DoD. W. Stuart Symington, the first Secretary of the Air Force, was sworn in on 18 September 1947, marking the official birth date of the USAF.

The new service retained the organization that General Carl Spaatz had originated in 1946, and which had its roots in the numbered air forces of WWII. It centered on three combat commands: the Strategic Air Command (SAC), Tactical Air Command (TAC), and Air Defense Command (ADC). In 1948, the Air Force Air Transport Command and the Naval Air Transport Service were combined to form the Military Air Transport Service (MATS). These four operational commands would form the backbone of the Air Force for the next 30 years.[2]

### Implementing the USAF Mission

DoD had thus acquired its modern form, but the individual services still required a concrete assignment of roles and missions, which was provided by the Key West Agreement of April 1948. This document laid authority for overall air warfare squarely on the Air Force and assigned specific primary and secondary responsibilities as well.

At its inception, the SAC strategic bombing capacity and practical deterrent power was rather limited, confined as it was to a small number of B-29 Superfortresses and a smaller number of atomic bombs. By 1948, these B-29s were gradually being replaced by the B-50 (a modified B-29 with more powerful engines) and by the new Boeing B-36 Peacemaker. The mammoth ten-engine B-36 — the largest bomber ever built — had a wingspan of 230 ft, length of 147 ft, and tail height of 47 ft. The B-36 was the subject of endless debate in discussions about the national defense strategy and the role of nuclear weapons in it. As force levels were continually restrained, it became clear that the Air Force would have to rely on a nuclear strategic deterrent, and growing numbers of the B-36 Peacemaker (385, eventually) were ordered in the late 1940s. They remained in service until 1956, when they began to be phased out in favor of an all-jet bomber fleet consisting of B-47s and the new B-52 Stratofortress.[3]

Hangars to house the growing stock of B-36s went up where needed. Both Ellsworth and Fairchild air force bases built a number of hangars based on the Corps of Engineers 39-05 standard plan series, which was primarily devoted to housing large aircraft. These buildings were of steel truss construction clad in galvanized steel. Their single-sloped form accommodated the massive aircraft nicely, as the nose was positioned at the lowest point of the shed and the tail at the highest point (Figure 5-1).

### End of the United States Nuclear Monopoly

America's nuclear monopoly came to an unceremonious end with the detonation of the first Soviet atomic bomb in 1949, and it appeared that by 1954 the Union

of Soviet Socialist Republics (USSR) would soon possess a usable stockpile of nuclear weapons. The ADC instituted a new program in the 1950s to provide for localized air defense of industrialized regions across the country. In support of this program, a series of alert fighter hangars was erected at installations supporting an ADC mission, including Seymour Johnson, Andrews, Kirtland, Wright-Patterson, Travis, Grand Forks, Minot, Malmstrom, and Holloman air force bases. These hangars were constructed from Office of the Chief of Engineers (OCE) 39-01 series plans that depict multiple-bay structures. Many of the early alert hangars were based on the 39-01-37 plans calling for a 298 x 66 ft flat steel truss structure with a four-bay layout. Later types were based on the 39-01-69 plans, which were similar but only featured two bays (Figure 5-2). An alert hangar constructed of prefabricated structural components was also utilized. This design shared the multiple-bay layouts, but featured a distinct series of gambrel forms (Figure 5-3).

SAC was thus intentionally taking the lead role in providing a U.S. deterrent force in the postwar world. Ironically, just as the B-36 was first entering the SAC inventory, it was the MATS that played the key role in the first crisis of the Cold War. Mounting tensions came to a head in June 1948 when the Soviets demanded the withdrawal of U.S. and Allied troops from West Berlin and cut off all land access to that city. The United States responded with the Berlin Air Lift, a herculean air supply effort dominated by some 300 C-54s from MATS that transported 2,325,000 tons of food, fuel, and other supplies to the citizens of West Berlin over its 14-month duration. MATS had proved itself in its first great test, and demonstrated the relative efficiency of a smaller number of larger transports over a larger number of smaller aircraft. The first military crisis of the Cold War had been defused without warfare, but the second would not be so peacefully settled, and other Air Force commands would play dominant roles.[4]

### *Eisenhower and the New Look*

#### Defending South Korea

The North Korean army plunged across the 38th parallel into South Korea on 25 June 1950 throwing Republic of Korea (ROK) forces and the few American supporting troops backward easily. USAF operations began that day, with the first air-to-air kills of the conflict scored by F-82 Twin Mustangs. For the next 5 months the USAF scrambled to mobilize a sizable force in the theater, and conducted three successful air campaigns to gain air superiority in the skies of Korea, provide close air support to American and United Nations (UN) ground forces, and conduct a short strategic bombing offensive against North Korean industry.

The relative ease with which the Air Force accomplished these goals in the opening stage against the North Koreans, after the initial panicked retreat to the Pusan Perimeter, came to an abrupt end when China entered into the conflict in November. The United States lost air superiority briefly as Russian-built MiG-15s outclassed older first-generation American jet fighters such as the F-80 and F-84. With the introduction of the F-86 Saber Jet in December, U.S. technical air supremacy was recovered and battlefield air superiority followed quickly. The F-86 maintained a 10:1 kill ratio throughout the remainder of the conflict, dominating the Korean skies and enabling the F-80s, F-84s, and some older WWII-vintage attack aircraft to provide effective close air support to friendly ground forces.

### Lessons Learned in Korea

USAF leadership took away a number of significant lessons from the experience in Korea. The flexible ability of strategic bombers to conduct close support carpet-bombing missions in the absence of strategic targets was a promising development, but not one that SAC leaders wanted to emphasize. They preferred to concentrate on the idea that the United States nuclear deterrent had kept the conflict isolated and moderated in intensity. The value of air superiority and close air support was vindicated, as was the vitality of technical air supremacy, but there was a feeling that the ease with which the United States achieved and maintained these objectives was illusory. New techniques for high-volume combat supply by airlift and air mobility of combat troops were vigorously supported, and the Pace-Finletter Agreements of 1951 and 1952 granted the United States Army freedom to pursue the potential of its rotary-wing program. Every one of these doctrinal revelations and validations would play a role in the formation of future Air Force policy.[5]

Perhaps more important than these doctrinal lessons was the feeling in the military community that the conflict had only been made possible by American military weakness. Along with this unsettling thought, it was soberly noted that the communist adversaries had not hesitated to resort to force to achieve their aims in Korea, and that the USSR controlled a viable nuclear arsenal of its own. With the Soviet nuclear threat now a reality, it became imperative to stop the next war before it could begin.

### Air Force Expansion and Continuous Mobilization

A new national defense policy called for continuous mobilization in order to achieve and maintain force levels that would deter communist aggression, and to support a defense industry capable of producing more and better military

hardware than could the communists. In 1953 President Eisenhower adopted a "New Look" for national defense strategies that emphasized constant readiness and a refusal to demobilize and risk further communist aggression. Great stock was placed in the principle of "massive retaliation," with its reliance on air power and nuclear arms as the primary means to deter future aggression.[6]

In order to ensure its deterrent ability, the Air Force was authorized to undertake a massive expansion, growing from a strength of 48 wings in 1950 to 143 wings in 1954. As SAC was the key to the Air Force's deterrent ability, it was the beneficiary of much of the force buildup. To reinforce the 300-odd B-36 heavy bombers in the inventory, new Boeing B-47 Stratojet medium-range bombers entered service in huge numbers, growing from a complement of 12 in 1951, to 329 in 1953, and more than 1,500 in 1958. With its swept wings and slung jet engines the B-47 turned out to be the prototypical large, modern jet aircraft, and its general form was to be mimicked by succeeding generations of both bombers and airliners. One such bomber was Boeing's giant B-52 Stratofortress, which entered service in 1955 and displaced the B-36 as SAC's main strategic bomber. While the B-47 was briefly replaced by the B-58 Hustler medium-range bomber, this supersonic high-altitude attacker was quickly phased out because it was not fast enough to outrun the newest surface-to-air guided missiles. This left only the versatile B-52 in the heavy bomber inventory, and it remains SAC's workhorse strategic bomber even today.

Air Force expansion and the New Look spurred a significant hangar-building program from 1952 to 1957. The double cantilever medium bomber hangar from the OCE 39-01 plan series dominated this effort. A two-bay structure measuring 350 x 250 ft was implemented from Standard Drawing 39-01-28. Improvements to this design were later set forth on Standard Designs 39-01-44, -46, and -58 (Figure 5-4). Although only two bays appear in the cross section of this hangar type (one arched and one rectangular), access from both the front and back sides of the building allowed for the servicing of four B-29s or B-50s at one time. Only two B-36s could be accommodated simultaneously, however.[7]

### New Fighter Technologies

Jet bombers were not the only area of technological development and expansion, of course, and second-generation jet fighters entered the Air Force inventory during this period in great numbers. Continued interest in maintaining technical air supremacy led to numerous requests for specialized aircraft that were tailored for individual missions: one design for interception missions, another for attack, another for air superiority, and another for all-weather air superiority.

The large number of developmental projects needed to satisfy these requirements could not be supported, however. The Air Force eventually accepted hybrid aircraft that could execute more than one mission, and used aircraft for missions other than those for which they had been designed. The F-105 Thunderchief is a fine example of the first option, as it was designed as a hybrid fighter-bomber — the first jet aircraft of this type. It replaced the F-84, B-57, B-66, and F-100 when it became operational in 1958. The F-104 Starfighter was an example of a plane pressed into service in a mission for which it was not designed. It was developed as a lightweight dayfighter, but would serve ADC as a long-range interceptor. Both of these aircraft were members of the "Century Series" of fighters — so called because their model numbers fell within the 100s — which became active in TAC and ADC between 1955 and 1959. They included the F-100 Super Sabre, the F-101 Voodoo, the F-102 Delta Dagger, the F-104 Starfighter, the F-105 Thunderchief, and the F-106 Delta Dart. All of these served until the 1970s or 1980s, and one — the F-106 — was only completely phased out in 1992. Other emerging technologies also affected these new aircraft and the means by which they would accomplish their missions. Increasingly complex and capable ground-based and airborne radar systems and effective surface-to-air and air-to-air guided missiles were perhaps the most influential. These technologies ushered in the era of long-range detection, interception, and destruction, and promoted changes in mission tactics made necessary by these capabilities.[8]

### The Strategic Impact of Intercontinental Ballistic Missiles

Perhaps the most significant technological development of this period came in the area of the ballistic missile. The Soviet Union had detonated its first atomic bomb in 1949, and by 1953 had developed a hydrogen bomb. However, the USSR was still behind the United States in delivery capability, relying on inferior heavy bombers to deliver nuclear weapons to the United States. Then, in 1957, the Soviets announced that they had put two satellites into orbit around the Earth, proving in the process that they had beaten the United States in developing the first functional intercontinental ballistic missile (ICBM). Suddenly, it appeared that the United States was losing the strategic arms race. Research and development efforts on ballistic missile systems were greatly accelerated, and America's first ICBM — the Atlas missile — became operational just a year after the Russian launch.[9]

Until the Atlas became available, SAC bombers remained America's sole deterrent force and DoD leaders feared a surprise attack by Soviet ICBMs, against which ADC interceptors would be ineffectual. SAC leadership took measures to ensure the survival of U.S. retaliatory power by enacting the SAC

dispersal program in 1958. Before this program, SAC based its strategic bomber force at 11 individual air bases, with one 45-plane wing per base. The new program called for each of these wings to be dispersed over three bases, with one 15-plane squadron and its supporting tankers at each location. This approach effectively tripled the number of targets that a Soviet attack would need to attach to destroy the United States bomber force, and it also reduced the amount of time needed to scramble each unit. To support the dispersal initiative, large aircraft maintenance facilities were completed at SAC bases such as Dyess, Eglin, Minot, Seymour Johnson, Wright-Patterson, and Grand Forks. OCE Standard Plan 39-05-12 was used to construct general maintenance hangars, often arranged in a distinct group a short distance from the runway (Figure 5-5). A typical layout of four hangars and one fuel cell (conforming to OCE Plan 39-01-13) appears to be standard as well (Figures 5-6 and 5-7). All of these structures are distinguishable by their offset gable form. Another interesting feature of the typical dispersal facility is a distinctive series of five ramps forming a herringbone pattern near the runway. Aircraft would stand on these ramps, ready for rapid deployment (Figure 5-8).

### *Origins of Flexible Response Policy*

The Cold War had begun to take on a changing character as the United States shifted toward a new strategic concept. The Soviet lead in missile development, coupled with a series of crises that included the Bay of Pigs in April 1960, the raising of the Berlin Wall in August 1961, and the Cuban Missile Crisis of October 1962, convinced President Kennedy that an alternative was needed to massive retaliation and mutually assured destruction. Not only did the President doubt the utility of starting nuclear warfare over every possible crisis, but he thought that the true deterrent power of the American nuclear arsenal would be diminished if enemies were to perceive that mutually assured destruction would inhibit U.S. leaders from using the nuclear arsenal to defend allies overseas. A way out of this strategic dilemma, in the form of a “Flexible Response” doctrine, had been proposed by Army Generals Matthew B. Ridgeway, Maxwell D. Taylor, and James M. Gavin as early as 1955. It had been strenuously opposed by Air Force leadership throughout the late 1950s, but found favor with Kennedy and Secretary of Defense Robert McNamara in 1961. This doctrine declared that the United States would not confine itself to an all-or-nothing response option, but would maintain a range of possible responses appropriate to a corresponding range of threats and levels of provocation. The United States must, therefore, be willing and able to respond effectively to a wide variety of strategic and tactical situations — especially those involving conventional warfare of a limited scope. Flexible Response would receive its first test in the jungles of Southeast Asia.[10]

### *Flexible Response in the Vietnam Conflict*

The United States involvement in Vietnam began at very low levels and slowly grew to the massive commitment that occupied the nation's armed forces throughout the late 1960s and early 1970s. A small number of military advisors in 1960 were joined by helicopter battalions in 1962. When a squadron of B-57s was attacked on the ground at Bien Hoa in 1964, Marines were tasked with airfield security and thus the United States began its large-scale ground force commitment.

Tight rules of engagement and target limitations restricted Air Force operations throughout the conflict. The most consistent mission type executed by the Air Force throughout its involvement was close air support (CAS) of U.S. and South Vietnamese ground forces. These missions employed a wide variety of aircraft, ranging from Korean War-era A-1E Sandies to new A-7 Corsair IIs, F-105 Thunderchiefs, and even B-52 Stratofortresses conducting carpet bombing attacks.

CAS efforts were coordinated by Forward Air Controllers (FACs) who opened the war with simple O-1 Birddog light aircraft, and graduated to OV-10A Bronco dedicated FAC aircraft and F-100 Super Sabre FastFAC ships. Early stages of the conflict saw the new F-4C Phantom II jet fighter winning air superiority over its MiG adversaries by taking advantage of its superior speed, power, and advanced missile armament. This aircraft — the last of the second-generation jet fighters — had problems with limited maneuverability and lack of internal cannon armament, however, which hampered dogfighting capabilities somewhat during earlier operations from 1965 to 1968. When air-to-air hostilities again picked up in 1972, however, the newer F-4E Phantom II, with its internal cannon, picked up where the F-4Cs had left off, dominating the skies over Vietnam for the remainder of the war.

A limited interdiction campaign had also been conducted during the first half of the war under the codename *Rolling Thunder*. This operation consisted primarily of F-105s conducting attacks on a very limited list of strategic targets in North Vietnam and, like the fighter offensive, was closed out in 1968 for political reasons. When the campaign resumed in 1972 as *Operation Linebacker,* the F-105s were joined by the new F-111 Aardvark supersonic swing-wing low-altitude bombers, which remain the Air Force's workhorse all-weather, pinpoint, smart-weapons delivery platform today.

Later in 1972, the first strategic air offensive was launched against North Vietnam in the form of *Linebacker II.* B-52s devastated Hanoi over an 11-day period and helped to drive the North Vietnamese to bring a close to the long peace talks

at Paris, which removed the United States from the conflict. During its dozen years in Southeast Asia, the United States Air Force had conducted more than 5.25 million combat sorties, shot down 137 MiGs, and dropped more than six billion tons of ordnance — nearly three times the amount delivered by the U.S. in World War II. It had sustained more than 6,000 casualties and lost 2,257 aircraft to all causes. Sixty-seven of these losses occurred in aerial combat, for a kill rate of 2:1.[11]

Relatively little new construction was required to support Air Force activities in the Vietnam conflict because most of these operations were staged from Asian bases. One substantial exception may be found in Travis AFB, which was expanded as a major transhipment facility. It received several hangars in 1969, including one specifically designed to house the new C-5 Galaxy heavy transport aircraft. This structure demonstrates a phenomenon in hangar design that began in 1952 and continues today — construction to accommodate basing needs generated by the introduction of a new aircraft type. Because a national aviation infrastructure was already in place by the start of U.S. involvement in Vietnam, large hangar construction campaigns were no longer needed. From that point forward, Air Force hangar construction occurred on a case-by-case basis.

### *After Vietnam*

The Air Force gained years of valuable experience during its activity in Vietnam, and the lessons learned there have made themselves felt through developments in new aircraft, technologies, tactics, and training methods. Budgetary constraints and a changing strategic environment have also affected Air Force operations, consistently requiring maximum results to be achieved with the minimum resources.

#### Third-Generation Fighters

Little new hangar construction took place between 1975 and 1986 due to budget constraints. Despite drastic budget reductions and a dramatic downsizing program that would bring the Air Force from a peak strength of more than 900,000 personnel in 1968 to 550,000 by 1979, it was clear by the end of hostilities in Vietnam that the Air Force needed an advanced third-generation jet aircraft for the late 1970s. The deficiencies of the F-4 Phantom II as a dogfighting platform were quite clear, and the Soviets were known to be producing new aircraft models at an alarming rate.

The United States responded with its new F-15 Eagle, which first flew in 1972. In 1974, the F-15 began to replace the F-106 and F-4 in the interceptor and air

superiority fighter roles. The Eagle retained all the advantages of its predecessors, with high speed and advanced avionics, but also excelled in those areas in which the Phantom and Delta Dart had been found lacking. Unmatched power and maneuverability, internal cannon, and advanced air-to-air missiles made it the premier air-superiority fighter in the world. Also in 1972 came the first proposals for the Air Force's new lightweight fighter program, which aimed at producing an inexpensive daytime dogfighter. This program eventually produced the F-16 Fighting Falcon which was first flown in 1974. The Falcon entered service in 1978 and has become the most widely used fighter in the Air Force inventory, filling multiple roles that include fighter, escort, and attack missions.

The A-7D Corsair II, which served as the Air Force's primary ground attack aircraft in the latter stages of the Vietnam conflict, began to be replaced in the late 1970s by the new A-10 Thunderbolt II (Warthog). This aircraft had first been conceived as a close support, anti-insurgency platform, ideal for the jungles of Southeast Asia, but as the conflict for which it had been intended was drawing to a close by the time it first flew in 1972, the Warthog was quickly reconfigured for an anti-armor role in the European theater to take advantage of its incredible endurance and formidable weapons loadout. These aircraft all proved very capable in their respective missions, and remain the Air Force's primary tactical fighters today.[12]

### Bomber and Fighter Modernization

The experience of the B-52s in the SAM-filled skies over Vietnam also convinced Air Force leadership that a new high-speed, low-altitude manned bomber was required to maintain SAC's deterrent ability. The resulting B-1 bomber first flew in 1974, but the program was canceled later by President Carter due to budgetary constraints and *detente* foreign policy. Instead, the Carter administration mandated a modernization program that concentrated on keeping aircraft in the Air Force inventory up to date with constant improvements, rather than replacing them with entirely new plane types. This modernization program has proven very efficient for a number of aircraft, including the B-52, F-111, F-4, and F-8 — all of which serve quite effectively today. The key element of this modernization program has been the continuous improvement in the electronics suites of these aircraft to keep them equipped with the latest technologies. Electronic warfare has developed very rapidly over the past two decades, with constant improvements in detection, targeting, jamming, and communications — headlined by the much-discussed stealth technology.

Budgetary constraints also emphasized the importance of the *Total Force* concept. This approach called for more rigorous training and up-to-date equipment

for the Air National Guard and Air Force Reserve which played an increasingly important role in performing the missions of a shrinking Air Force. No longer could these elements be allowed to train sporadically using outdated aircraft and tactics if they would later be expected to perform like front-line units in a war. Significant strides were made toward bringing these units up to speed, including their involvement in the new combat exercises being developed in the Air Force. Despite the budgetary constraints, such expensive new training programs as the Red Flag combat exercises were developed in the 1970s. These provided realistic combat-environment training for Air Force pilots and crews. Created in response to the declining kill ratios of the Vietnam War, Red Flag and its companion programs have greatly increased the efficiency of American air crews, a fact proven repeatedly when U.S. forces are committed around the globe in crisis situations.[13]

### *Reagan Administration Policy and the End of the Cold War*

The budgetary constraints of the late 1970s were reversed by a deliberate expansion of the United States armed forces under the Reagan administration. One of Reagan's early moves was the reinstatement of the B-1 project, leading to the acceptance of the first of the controversial B-1B Lancer strategic bombers in 1985. Hangars to house the B-1 went up at Grand Forks AFB in 1987. Further development was also funded for research in "stealth" technology, leading to the commissioning of the super-secret F-117 Nighthawk (Stealth Fighter, Black Jet) in 1983, and the less-secret B-2 Stealth Bomber in 1992. In 1992 Holloman AFB received a series of hangars to house the F-117A.[14]

A series of international actions under Presidents Reagan and Bush included Air Force involvement, ranging from regular surveillance missions over Nicaragua and El Salvador, to transport and gunship missions in Operation Urgent Fury over Grenada in 1983, precision bombing in Operation El Dorado Canyon over Libya in 1986, and a range of tactical and transport missions in Operation Just Cause over Panama in 1989 to 1990. All of these deployments — and especially the Persian Gulf War of 1991 — vindicated the Air Force's post-Vietnam policies. The Total Force concept proved successful, as Reserve and Guard units performed well under combat conditions, and the results of technical air supremacy and state-of-the-art training programs were clearly seen. The Iraqis were simply unable to compete with U.S. crews, aircraft, and technology.[15]

Ironically, the organization that returned so triumphantly from over the sands of the Middle East immediately underwent reorganization, as renewed budget cuts brought more downsizing in response to the dissolution of the Soviet Union and European communism. In anticipation of a force-reduction program scheduled to

bring the strength of the USAF down to 430,000 personnel by 1997, a new organizational structure was introduced in 1992 that combined SAC and TAC into the Air Combat Command (ACC), and reformed MAC and some SAC aerial refueling elements into the Air Mobility Command (AMC). Furthermore, combat wings may no longer be restricted to single plane types, but may in the future constitute small, multi-role air forces able to meet emergency commitments as a flexible, preformed unit.[16]

As missions change and Base Realignment and Closure (BRAC) activities continue, hangars will be constructed to meet evolving installation needs. Well established definitive design programs are in place to meet these demands. While hangar construction technology is not likely to change, the military aircraft inventory will continue to adapt and thus will require future craft-specific hangars.

## Postwar Aviation Construction Drivers for the Other Services

### *Army Aviation Construction Drivers*

#### The Early Cold War and Korea (1946 – 1953)

WWII had indeed demonstrated the importance of strategic air power, and the Army Air Forces were intent on taking advantage of that fact to gain their long-awaited independence from the Army Ground Forces. The Air Force finally achieved independent, coequal status in 1947. In the eyes of the Army, the new Air Force's fixation on its strategic roles and missions promised little traditional close air support for ground units. Moreover, the Army lost its organic flight units, with the exception of about 200 small liaison planes. The Key West Agreement of 1948 spelled out the respective roles of the various services' air arms, leaving to the Army only the control of fixed-wing aircraft lighter than 2,500 lb and rotary-wing aircraft (i.e., helicopters) lighter than 4,000 lb. Essentially, Army aviation was confined to air transport for Army units, reconnaissance, and courier missions while the Air Force executed all strategic and tactical combat missions. Still uneasy with this arrangement and the possible neglect of air support that they felt would result, Army officials would campaign throughout the period for an increased organic air mission, often against stiff resistance from the Air Force establishment.[17]

MAJOR THEMES AND CONTEXTS

Air Mobility Construction

Division 86 Facilities

***The Advent of Helicopter Aviation.*** A major component in the Army's struggle to expand its organic air mission was the growing field of helicopter aviation.

The Army Air Corps had actually begun testing helicopters as early as 1930, but halted this process in 1936 due to frequent accidents. The first helicopter purchased by the War Department in numbers was the Sikorsky VS-316, the first of which were delivered in 1940. The VS-316 had both cyclic- and collective-pitch control systems, and it had a tail rotor with variable pitch that could be used to steer like a rudder. It was in this machine, designated the R-4 by the Army Air Forces, that Colonel Philip Cochran — Commander of the First Air Commando Group in Burma — conducted history's first helicopter evacuation of wounded personnel on 3 May 1943. The Army Ground Forces began exploring the use of helicopters in flight missions in early 1945, and Captain R. J. Ely became the first Army Ground Forces helicopter pilot when he completed rotary-wing training at Scott Field, IL. In 1946, Army Ground Forces acquired their first rotary-wing aircraft — 13 Bell YR-13 helicopters — which were given the designation H-13.

After the separation of the services in 1947, the Air Force continued to train Army pilots at Gary AFB, TX, until November 1948. At that point, Army pilots — who complained that they were being graduated with only 25 hours of flying time under Air Force tutelage — were transferred to their own training program at Fort Sill, OK. The Army established its Helicopter Advanced Training Course with the help of Bell Helicopter Company, and proceeded to train its pilots on its own aircraft and in its own manner. The first class graduated at Fort Sill in December 1948, and instruction continued as the school was renamed the Army Field Forces Helicopter Pilot Course (in July 1949) and, later, the Helicopter Aviation Tactics Course (in August 1951). Fort Sill also became the site for fixed-wing aviation pilot and spotter training courses during this period. The Army's entry into helicopter aviation had come at a fortuitous moment, opening new horizons even as its fixed-wing operations were being questioned by the Air Force. Both types of flight operations would prove crucial to the Army's success in the conflict that erupted in Korea on 25 June 1950.[18]

***Army Aviation in Korea.*** Fixed-wing Army aviation entered the fighting on the very first day, as two aviators evacuated U.S. military advisors from collapsing South Korean units before they fell into North Korean hands. Light aircraft units assisted in the rapid retreat of U.S. and South Korean forces before the onrushing North Koreans. Newer L-17s, -19s, -20s, and -23s replaced World War II vintage planes in traditional light aviation roles as the United States and allied troops established the Pusan Perimeter, then counterattacked north in conjunction with the Marine Corps landing at Inchon.[19]

Few helicopters were in Korea at the start of hostilities, but some of the first missions flown by these aircraft in the opening months of the war were medical

airlift flights by Helicopter Detachment F of the 3rd ARS, USAF. The Army saw great promise in these missions, as they proved the utility of these aircraft in a designated Army air mission. U.S. Army helicopters did not enter the war in larger numbers until just after the Chinese invasion of November 1950. These H-13s immediately began medevac missions, and by November 1951, the Army had sent more than 125 helicopters to Korea.[20]

With the exception of these helicopter medevac missions, the roles played by Army aviation were much the same in Korea as they had been in WWII. Light aircraft — especially the new L-19s and L-20s — performed the familiar missions of reconnaissance, artillery spotting, light transport, ground direction, and forward air controller. The main difference between the two conflicts was the organization of the Army's aviation assets into light aviation sections that supplemented the piecemeal assignment of aircraft to smaller ground units. Lieutenant General Isaac Davis White had organized these aviation units by drawing into a central pool all the light aircraft not absolutely necessary to the ground units' missions, such as medevac helicopters and artillery spotting airplanes. The aircraft of this central pool were then assigned to conduct missions in support of the ground forces on a priority basis. Most ground forces' commanders agreed that the light aviation section system worked well and was an efficient utilization of aviation assets, but many still felt that they needed greater numbers of aircraft under their direct control, in addition to the central pool upon which they could draw when necessary.[21]

The other significant development of the Korean conflict was the organization of airmobile infantry formations. Having seen the helicopter's ability to transport people out of a combat area, it occurred to Army officials to explore its other uses as well. A proposal to organize a number of helicopter-mobile infantry battalions in October 1950 met strong opposition from the Air Force on the grounds that it violated the 1947 agreement on the size of Army helicopters. Insisting that Air Force units would be unable to provide the dedicated air support necessary to the modern combat environment as efficiently as organic Army aviation assets, Army officials eventually signed an agreement with the Air Force eliminating the weight restrictions from the previous agreement and dividing air missions by function instead. This Memorandum of Understanding, signed 2 October 1951, employed fairly broad language in defining the Army's air missions, allowing it sufficient leeway to develop light aircraft and helicopter aviation to meet its future needs.[22] Development of heavier rotary-wing aircraft technology and doctrine proceeded at home thereafter. The Army Corps of Engineers drew up plans for a standard hangar specifically intended for Army organic light aircraft. This plan (39-01-26) shows a long, shallow four-bay building of steel truss

construction (Figure 5-9), not unlike the alert hangars being constructed at the same time by the Air Force.

The 6th Transportation Company (Helicopter) took part in Exercise SNOWFALL, at Camp Drum, NY. This exercise spanned January and February 1952, and the helicopter unit served well in transporting injured paratroopers to field hospitals. In 1953, exercises SNOWSTORM and DESERT ROCK demonstrated the helicopter's ability to transport combat troops long distances to their target areas.[23] This unit was then the first of the new helicopter transport companies to enter service in Korea when its new H-19 Chickasaws arrived in the country in March 1953, near the end of the fighting. These new transport companies saw little action before the Armistice in July 1953, but the Army had convincingly made its case for the importance of helicopter aviation to the efficiency of its field forces. The idea of airmobile infantry had not been tested under combat, but the idea was set firmly in the minds of the Army's upper command structure, and it would come to dominate doctrinal developments in the decade after the withdrawal from Korea.[24]

***Growth of the Army Aviation Program.*** In addition to advances in doctrine, the Korean conflict spurred significant growth in U.S. Army aviation. Before the opening of hostilities in June 1950, the Army had been authorized a modest $2 million for procuring aircraft for the 1951 fiscal year. A new Army emergency budget, which was approved in response to the Korean crisis, earmarked more than $42 million for purchasing aircraft, and this dramatic plus-up fueled a rapid expansion of the Army's aviation capabilities. Whereas the Army had 63 H-13 helicopters at the start of the Korean War, by December 1954 it had more than 700. In 1950, the Army owned only a single Hiller H-23 light helicopter, but it had nearly 200 by the end of the war.

Newer types were also introduced in increasing numbers as the conflict progressed. The Sikorski H-19 was first delivered in June 1952. Within a year the Army had 72 in the inventory, and was already clamoring for its replacement, the larger, more powerful Sikorski H-34. The H-25 and H-21, both twin-rotor models built by Piasecki, entered service in 1953 and 1954, respectively. Both expanded rapidly in numbers beyond the war, with the H-21 reaching more than 300 by 1962.[25] More of pilots were required to fly these new aircraft, of course, so training operations increased pace, with nearly 1500 pilots graduated by the end of hostilities.[26] Thus, by the end of the Korean War, Army aviation had grown profoundly in size, mission, and doctrine, and further growth would continue over the following decade.

Despite increases in the Army's helicopter inventory and subsequent expansion of training activities, there was little growth in terms of physical facilities during this period. An aviation infrastructure left over from the Army Air Forces, was already in place. Only sporadic hangar construction occurred at the installation level; examples can be found at Fort Irwin, CA, and Fort Lee, VA.

### The Vietnam Conflict (1954 – 1974)

The period between the Korea and Vietnam conflicts witnessed the birth of the Air Cavalry and Army air mobility doctrine, significant technological advances in both fixed- and rotary-wing aircraft and avionics, and significant growth in the Army's aviation facilities to accommodate the growing air arm. Great strides were made through the late 1950s and early 1960s, and by the time the fledgling 1st Cavalry Division deployed to Vietnam, it had come a long way toward making itself a viable combat formation, with all necessary personnel, equipment, and doctrine. Even more advances would have to be made under fire in the jungles of Southeast Asia.

***Growth in Training Requirements.*** The great expansion in Army aviation capabilities spurred by the Korean conflict quickly outstripped the capacity of Army technical facilities. The Army Aviation School at Fort Sill had been run in conjunction with the Artillery School at that location since 1942. The 50 staff members, 125 students, and 100 aircraft that had constituted the school in 1950, however, had grown to 300 staff, 800 students, and 500 aircraft by 1954.[27] New facilities would be needed to accommodate this expansion, and this need was met by the new Army Aviation School at Camp Rucker, AL.

There were a number of practical reasons to establish the school at Camp Rucker, including the fact that it already had three 5,000 ft runways at Ozark Army Air Field as well as some new buildings. In addition, huge truck stands would serve well as helicopter landing aprons, and truck repair facilities could be used as helicopter repair hangars. Construction of new facilities and modification of some old ones followed throughout the end of 1954 and early 1955, including a number of landing fields and facilities for fixed-wing aircraft. Thus, Fort Rucker became the new home of the Army Aviation School in October 1955. By 1956, the Army was entirely responsible for the training of its pilots at Fort Rucker and Fort Wolters, TX. By 1959 fixed-wing training was also concentrated at the Army Aviation School at Fort Rucker.[28] Six of Fort Rucker's hangars built in 1958 and 1959 for these purposes are still used for aviation purposes today.

From 1954 to 1956 Camp Stewart expanded its training mission, and by March 1956 it was designated Fort Stewart. Seven hangars were constructed in the in-

terim at nearby Hunter Air Force Base, later falling under Fort Stewart ownership and known as Hunter Army Airfield.

***The Air Cavalry Concept.*** The physical expansion of the Army's aviation facilities coincided with significant development in Army doctrine and the role of the helicopter in future Army operations. In the years following the Korean War, commanders such as General Matthew B. Ridgeway grew increasingly concerned over the Army's role in the nuclear battlefield, and its ability to accomplish its mission in that environment. Observing the Air Force's concentration on its strategic arm, ground forces leadership feared that its tactical air support and transportation roles would be slighted. They saw a pressing need for the development of an organic Army aviation capability that would allow the ground forces to function efficiently on the nuclear battlefield by providing dedicated airmobile transport, supply, and fire-support assets.[29] The lessons of the Korean War had convinced Army leadership that helicopters and light aircraft could successfully be employed to provide these assets. In 1954, Major General James M. Gavin proposed the organization of a new force composed of helicopter- and light-aircraft-borne infantry who would use their superior mobility and stiff striking power to carry out those missions that had been the traditional duties of cavalry — especially reconnaissance, screening, and deep strike missions. Gavin's ideas caught the attention of the first Director of Army Aviation, Major General Hamilton H. Howze, who referred to the units as *air cavalry*, and saw great potential for them, both in the nuclear battlefield environment and in more limited "brushfire" wars as well.[30]

The construction program launched to support the air cavalry was dominated by two standard Army Aviation Facilities hangars: OCE plan number 39-01-62, entitled "12,000 Square Feet – 20,000 Square Feet With Shops," and 39-01-64 for "20,000 Square Feet – 35,000 Square Feet With Shops." Both plans are essentially identical, with variation only in scale (Figures 5-10 and 5-11). These gabled steel truss structures are still in aviation use at Fort Sill, Fort Huachuca, Fort Knox, Fort Belvoir, Fort Hood, and the former site of Fort Gillem. While these plans were developed in the late 1950s, examples of their use can still be found as of late 1980s.

***Airmobility for Flexible Response.*** The Army spent a number of years testing Gavin's ideas in exercises at Fort Rucker, Fort Sill, and Fort Benning, GA, and by 1960 it was beginning to acquire more advanced aircraft. The early 1960s then brought President Kennedy's move away from Eisenhower's New Look doctrine of massive retaliation toward the more conventional Flexible Response strategy that had the potential of involving U.S. armed forces in non-nuclear conflicts around the world. Needing to meet increasing conventional force

requirements quickly with as little expansion as possible, Secretary of Defense Robert McNamara seized on an airmobile Army as a practical solution. In 1962, he commissioned the Howze Board to study the airmobile concept in field exercises at Fort Stewart, GA. The board was immediately impressed with the possibilities of the concept, and recommended that the Army acquire as many helicopters as possible to replace wheeled vehicles and increase mobility.

McNamara accepted the Howze Board's findings and in January 1963 directed the Army to assemble and test an airmobile division. The 11th Air Assault Division began exercises at Fort Benning and Fort Stewart, experimenting with air assault and close support methods. They found advantages and disadvantages to the new system, which offered great mobility and flexibility, but also suffered from a vulnerability to enemy armor, antiaircraft defenses, and harsh weather.[31]

The developments in doctrine were only made possible by concurrent technological advances in rotary-wing aviation. The helicopters available to the Army in Korea would have been unable to support the new air cavalry doctrine, but the late 1950s saw much development of the helicopter as an effective transport and weapons platform. Instrumentation was greatly improved and experimentation showed that helicopters could operate quite well in adverse weather conditions — even better than conventional aircraft in fact. Power was immensely increased with the adoption of the turbine engine, which was capable of running efficiently at high speeds and high temperatures for extended periods, and weighed less than their piston-driven predecessors. These engines allowed for smaller, lighter, more powerful helicopters that were capable of sustained hover and high speeds with greater passenger and fuel loads. The best example of the new turbine-driven helicopter was the Bell UH-1 Iroquois, which won a 1955 design competition and became the Army's ubiquitous "Huey" utility helicopter.

Tests were also conducted in the use of helicopters as flying gun platforms, armed with machine guns and rockets. The use of rotary-wing aircraft in this role met opposition from the Air Force, and from Army personnel in the Transportation Corps who feared that they might lose control of all helicopter assets to the Air Force if matters came down to a decisive judgment one way or the other. It was not until 1960 that the use of weaponry was approved for helicopters, creating new missions for Army aviation in ground support and attack roles.[32]

The UH-1 Huey was not the only helicopter developed and adopted by the Army prior to Vietnam, of course. The H-13s, H-23s, and H-19s that closed the Korean War were quickly joined by larger and more powerful models, including the H-34 and H-37 Mohave cargo helicopters in 1954 and 1956, respectively. The last of the huge cargo helicopters to reach service were the giant CH-47 Chinook and

CH-54 Skycrane, which provided the Army's premier heavy lift capability in Vietnam. After the Huey's acceptance in 1960, it underwent four developmental stages, increasing payload, power, maneuverability, and range. Further, a gunship variety — the UH-1B — was introduced in 1962, and led directly to the development of the first purpose-built helicopter gunship — the AH-1 Cobra, which entered combat in Vietnam in 1967. A fourth type of helicopter designation, complementing the cargo, utility, and attack types, was the observation helicopter. The newest observation helicopter to join the inventory during this period was the OH-6 Cayuse, which entered service in 1963.

***Fixed-Wing Developments.*** Fixed-wing aircraft also saw significant development during the period, especially in the OV-1 Mohawk. The Army's light aircraft until this period consisted of low-performance civilian types such as the Piper Cub. The O-1 Bird Dog (formerly the L-19) remained in service as the chief example of this type of aircraft. The OV-1, however, was an entirely different kind of airplane, developed by the Army to perform its observation and spotting missions in an increasingly complex combat environment. Mohawk development began in 1959 as a joint Marine Corps-Army engineering project, but the Marines withdrew from the project before long.

The Army continued development and Grumman produced the first operational Mohawk in 1960 after a lengthy test program. The OV-1 immediately changed the face of Army light aircraft aviation, with its twin turboprop engines providing speeds in excess of 450 mph, as opposed to the 115 mph maximum speed of the Bird Dog. Moreover, the Mohawk was developed with a complex electronic battlefield in mind, and employed Sideward-Looking Airborne Radar (SLAR), infrared, and photographic instruments to observe the enemy and direct friendly artillery and air assets in the attack. These versatile aircraft were even armed with rockets and gun pods in Vietnam, and proved quite valuable in close air support, FAC, and FAO (forward air observer) missions.[33] It would be there, over the jungles of Southeast Asia, that the Army's developing airmobile doctrine would receive its first test under fire.

***Army Aviation in Vietnam.*** America's military commitment began in 1955 with the deployment of the first 300 military advisors. In December 1961, the first Army helicopters entered the country — the H-21s of the 8th and 57th Transportation Companies (Light Helicopter) — which were used to airlift Vietnamese troops in pursuit of Viet Cong guerrillas. The first armed Hueys arrived in country in September 1962. These machine gun- and rocket-armed aircraft provided close air support for the Hueys' airlift operations, to the great consternation of the Air Force, who watched closely to ensure that the Army aircraft did not usurp any of the Air Force's CAS and interdiction missions.

In 1964 President Johnson committed the first American ground combat troops, U.S. Marines who were tasked with the security of the growing Air Force presence at Vietnamese air bases. These Marines were soon supported by increasing commitments of the United States Navy and Air Force. In September 1965 the 11th Air Assault Division combined with the 2nd Infantry Division to form the 1st Cavalry Division, which deployed to Vietnam with the task of pursuing the Viet Cong guerrillas to their jungle hiding places and rooting them out.[34]

Search-and-destroy missions were standard operating procedure for U.S. units in Vietnam. The Army employed airmobile infantry (air cavalry) to achieve superior mobility in the rough terrain in order to pursue, surround, and annihilate enemy units. Helicopters provided troop transport, supply, reconnaissance, and fire support missions in these operations, and became so crucial to Army operations in Vietnam that few exercises did not include an aviation element. The four light helicopter companies in the Army at the beginning of 1964 had expanded to 45 by June 1966.[35] The Army found it very hard to keep up with the demand for pilots and helicopters, and this made it necessary to shorten the flight training program and repeat duty tours for aviators. By 1967 the AH-1 Cobra had entered combat, providing close air support for assault companies or acting in conjunction with OH-6 Cayuse light observation helicopters as hunter-killer elements. In July 1968 a second airmobile division — the 101st Airborne Division (Airmobile) — was organized in Vietnam. For administrative purposes, its aviation assets were combined with the 1st Cavalry's within the 1st Aviation Brigade (Provisional). Operationally, however, 101st Airborne unit commanders exercised combat control.

As with Air Force efforts, Army aviation activities in Vietnam were largely staged from bases in the Pacific. Aviation construction in the continental United States was mostly for fixed-wing and helicopter training facilities. Many hangars to support this mission were built at Fort Hood, Fort Rucker, and Fort Stewart between 1965 and 1970. Some Navy hangar types were used by the Army, because they were suitable for helicopter maintenance. By 1970, the Army was favoring prefabricated hangars for their fixed-wing aircraft, as they provided inexpensive and quickly erectable solutions for their limited needs.

### After Vietnam

The end of the Vietnam conflict ushered in a period of continued technological and doctrinal development for U.S. Army aviation. The late 1970s brought a return in the Army to an emphasis on the Soviet threat, resulting in new strategies and new force structures to meet the Warsaw Pact adversary in Europe. Because mobility and firepower were held at a premium in this environment,

Army aviation assumed a growing role in tactical and assault transport, and in close air support. New aircraft had to be developed to perform these missions in Europe's high-threat environment, and these much-improved machines reached a growing body of airmobile and aviation units in great numbers throughout the period.

Army doctrine after Vietnam refocused on the Soviet Union and Eastern Europe. The divisional organization of the mid-1970s was essentially the same as that for the Vietnam conflict, but with some small deviations. In anticipation of the need to fight as individual units in the face of a numerically superior Warsaw Pact attacker, the Army divided up support functions among organic units so each division had some of its own support units. There were only three types of divisions — armored, infantry, and mechanized infantry — and each type included some organic airmobile components. There were, in addition, a small number of specifically airmobile formations, such as the 1st Cavalry and 101st Air Assault Division.

***Division 86.*** After-action reports following the 1979 REFORGER exercise convinced Army leadership that the existing organization and doctrine for aviation assets were unsatisfactory. It was apparent that units of the North Atlantic Treaty Organization (NATO) would be forced to fight at a numerical disadvantage through the bulk of any foreseeable conflict, and that some means had to be devised by which they might contend with superior Warsaw Pact numbers. The solution arrived at was a system of maneuver warfare by which American and allied forces would avoid meeting the enemy strength on strength, but instead would rely on rapid maneuvers and short, sharp attacks that would mitigate the disadvantages of their inferior numbers.

The new Army doctrine, called AirLand Battle, stressed combined arms tactics that aimed at utilizing firepower and mobility to unbalance the opponent, seize initiative, and destroy the attacking enemy. The Division 86 organizational system was adopted in 1983 to support this doctrine, and further emphasized the autonomy of each individual division. Regular infantry divisions were eliminated in favor of all-mechanized formations, and their loss was compensated for by the bolstering of each armored and mechanized infantry division's airmobile contingent. The concept emphasized mobility and firepower. Army aviation was regrouped into *combat aviation brigades* with flexible organizations and assignments. These units took advantage of their superior mobility and the striking power of their airmobile infantry and attack helicopter assets to deepen the battle area and attack the enemy's weaknesses while avoiding its strengths. This doctrine would carry the United States Army to the end of the Cold War and the dissolution of the Soviet threat to Western Europe.[36]

***The Rise of The Attack Helicopter.*** The last phase of the Cold War saw significant technological development for Army aviation to match its doctrinal developments. Perhaps the most important of these advances were those made to the attack helicopter. Tests were conducted in the early 1970s to determine whether the airmobile concepts that the Army was finding so useful in Vietnam could also be applied successfully in Europe. The initial Air Cavalry evaluations in 1970 proved quite positive, and the Ansbach trials of 1972 followed to determine the helicopter's survivability in a high-threat environment. It was found that helicopters using nap-of-the-earth (NOE) flying techniques, wherein they flew very low to the ground and took advantage of any available cover to hide from enemy observation and attack, performed well in this environment and could even operate in conditions that would ground fixed-wing aircraft. It was also determined that helicopters utilizing NOE tactics could successfully engage armored units if they could be equipped with the right kind of anti-armor weapons, such as cannon, missiles, or rockets.[37]

This revelation must have come as quite a shock to some in the aviation community, as U.S. Army helicopter pilots had never been trained in NOE tactics and the new H-56 Cheyenne attack helicopter that was then in development could not fly NOE. The H-56 was designed to execute the long, high-speed, diving attacks that were favored by Army pilots in Vietnam, but this style of air combat simply was not possible in a high-threat environment. As a result of these tests, however, NOE training was immediately begun at Fort Rucker, and the Cheyenne program — already under fire due to its troubled developmental history — was canceled.[38] The NOE training program used aviation structures already existing at Fort Rucker for the Army program, and therefore, no hangar construction took place.

The need for a modern attack helicopter had never been greater, so the Cheyenne program was replaced by the Advanced Attack Helicopter (AAH) design program, instituted in 1972. It was decided that the AH-1 Cobra would be fitted with the tube-launched, optically tracked, wire-guided (TOW) antitank missile system as a stopgap measure until the AAH program bore fruit. A series of tests and developmental models of the Cobra were produced, experimenting with increased weapons loads and the more powerful engines necessary to perform with them. These developments resulted in a string of Cobra models ranging from the AH-1G through the -Q to the -S, the -E, and finally the -F. This latest model still serves today for the Army Reserves, National Guard, and U.S. Marine Corps. At its peak there were 1,081 in service.[39]

The AAH program may in fact have been slowed by the fact that the Cobra proved to be such a serviceable and inexpensive attack platform. With this

aircraft in the inventory in large numbers already, it seemed that there was little need for a more advanced attack helicopter, and funding for such systems could often be very hard to secure. The first requirement specifications for the AAH were approved in 1972, calling for unprecedented performance in many areas, especially speed, endurance, and survivability. The Phase I operational testing competition between the Bell and Hughes designs was resolved in favor of the latter in 1976, but the program then fell on hard times due to budget constraints during the Carter administration. It was not until 1981 that Phase II testing began, at which time the new AH-64 Apache impressed all observers.

The Army pushed ahead for immediate production, with the first orders delivered in 1982 and increasing rapidly throughout the 1980s. The final production run is scheduled to close out with a total of 807 aircraft in service. The Apache is perhaps the most powerful rotary-wing attack aircraft in the world, capable of flying in night and adverse weather conditions at speeds over 200 mph. It has great maneuverability, survivability, and endurance, and is armed with a 30mm cannon and up to 16 Hellfire antitank missiles.[40]

Less glamorous, perhaps, but no less important to the Army's air missions was the development of the UH-60 Blackhawk. This powerful utility helicopter, having begun development as early as 1965, began to replace the ubiquitous UH-1 "Huey" in 1978. Like the Apache, the Blackhawk's development was slowed due to the exemplary performance of the Hueys it was supposed to replace. The first prototype flew in 1974, with production beginning in 1977. The Blackhawk is a great improvement over its simple predecessor in speed, power, endurance, payload, reliability, and survivability. Today, it forms the backbone of the Army's rotary-wing aviation assets, serving with nearly every division in the Army and comprising the primary mode of transport for the airmobile divisions.[41]

The adoption of the various new aircraft in growing numbers, and the increasing role of airmobile units and attack aviation in the Army's developing doctrines have required a great deal of physical support. Hangar construction boomed in the years between the end of the Vietnam conflict and the end of the Cold War. Nine hangars were erected at Fort Hood, for example, four at Fort Polk, and three each at Fort Riley and Fort Campbell.

***Army Aviation Beyond the Cold War.*** In the years following the end of the Cold War, Army aviation has continued to execute its crucial roles in the Army's doctrine of Mobile Warfare. Construction to support this mission is ongoing, with 1990s-era hangars being erected in significant numbers. Fort Campbell received five hangars between 1990 and 1992. Four hangars went up at Fort Drum's Wheeler-Sack Army Airfield in 1992 following the construction of a new

airfield. These facilities accommodate the transportation of active Army and Marine personnel in and out of Fort Drum for winter training exercises. Aviation facilities erected at Fort Stewart in the 1980s and on into the 1990s are in direct support of Fort Stewart's Rapid Deployment Force and associated training mission. The 1990 hangars at Fort Stewart's Hunter Army Airfield currently house maintenance activities for their Chinook and Blackhawk helicopters. This use is typical of the structures that continue to dominate Army aviation construction.

### *Postwar Navy and Marine Corps Aviation Construction Drivers*

#### Demobilization in the Late 1940s

As was the case with other services, the impact of postwar demobilization was not long in coming for the Navy. In the first year after Japan's surrender, some 2,600 vessels of all types were mothballed and even more were simply scrapped. By December 1946 the Navy retained in operation only 319 major combat vessels and 724 auxiliary ships. Of more than 100 aircraft carriers in service at war's end, only 23 were still in service at that point. By the opening of the Korean War in 1950 the number had been further reduced to just 15. The Navy's and Marine Corps' air arms were down to one-quarter of their wartime strength, and much of their equipment was also in storage.[42]

MAJOR THEMES AND CONTEXTS

Constant *ad hoc* Expansion

The formation of the new Department of Defense in 1947 marked one of the high points in an ongoing debate within the defense establishment about the direction of U.S. postwar national defense strategy. For advocates of naval air power, the establishment of a separate and co-equal Air Force signified a political victory for the opponents of the Navy's air arm. The Air Force touted the superiority of its nuclear deterrent as the first line of the nation's defense, at the expense of naval aviation. A robust inter-service political brawl swirled around the question of the relative military strengths and cost-effectiveness of the Air Force's long-range heavy bombers versus the Navy's aircraft carriers. Advocates of the heavy bomber argued that the carrier had become obsolete in the nuclear age while naval officials maintained that their premier capital ship continued to serve well a visible and flexible force projector that the bomber could never replace. With the strength of the Soviet Union's navy at a modern low point, it appeared to some that the need for a strong Navy based on aircraft carriers was a luxury that the United States could well do without. The Navy attempted to answer the nuclear question with its first supercarrier — the *USS United States* — which was to be

large enough to support its own nuclear-armed bombers. The keel was actually laid on this immense vessel, but the project was quickly canceled by the Truman administration in favor of enhanced strategic air power within the Air Force. As the 1940s came to a close it appeared that naval air power might in fact have started down the road to oblivion. This trend, however, was brought to an immediate and dramatic halt by developments during the opening phase of the Korean War in 1950.[43]

Some limited development was sustained in the Navy's air arm as the jet age dawned. The test flights of an FD-1 Phantom off the deck of the *USS Franklin D. Roosevelt* marked the first time that a jet aircraft operated off a U.S. carrier. By 1949, FH-1 Phantoms had been adopted as the Navy's first operational jet fighter. They were joined by the propeller-driven AD-4 Skyraider, which served as the Navy's premier close air support and strike aircraft well into the Vietnam conflict. These new models were still augmented by a large number of WWII-era aircraft such as the F4U-Corsair, which continued to serve as the Marine Corps' premier fighter-bomber.

Only one hangar was constructed for the Navy during the late 1940s. This maintenance hangar was erected at the new Naval Air Weapons Station at Point Mugu, CA, in 1949 to support weapons and aircraft development efforts.[44]

### From Korea to Vietnam

Naval aviation experienced a resurgence during the 1950s and early 1960s resulting from two primary factors: the pivotal role played by carrier aviation during the Korean War and significant growth of the Soviet navy. During the first frantic months of the Korean War in the summer of 1950, Navy aircraft carriers provided critical air support to U.S. and ROK ground forces as they retreated to the Pusan Perimeter. The Navy's ability to quickly divert air power aboard its carriers to the combat theater provided its most potent argument for a continued role in U.S. national security in the nuclear age. While carrier groups were unable to contribute to a nuclear deterrent, their ability to provide a fast, flexible response to international crises continued to make them a valuable strategic asset in the nation's defense establishment. Naval aircraft provided close support to MacArthur's daring Inchon landing in September 1950, and continued to conduct close air support and interdiction missions as United Nations (UN) forces drove north toward the Yalu River. Naval and Marine Corps aircraft maintained these missions throughout the remainder of the war until the armistice in July 1953. The valuable contribution made by carrier forces during the course of the Korean War effectively ensured the future of naval aviation in the Cold War strategic environment.[45]

The other primary driver of naval aviation expansion was rapid growth of the Soviet navy and air force. Recognizing the futility of trying to compete with the United States in surface vessels, the Soviets chose to build their submarine fleet instead. They also greatly increased their strength in long-range attack bombers, which could threaten U.S. carrier groups that were operating a great distance from enemy shores. By the close of the 1950s, the Soviets ranked third in the world in naval power, behind only the United States and Great Britain, and the Soviet navy continued to expand in the early 1960s. While they still could not compete with the United States and its allies on the open seas, Soviet submarine and bomber threats did impair NATO's ability to secure maritime traffic in the North Atlantic sea lanes and in the Western Pacific. The United States and its NATO allies viewed the North Atlantic as particularly crucial in any future European war, as it had proven to be during both World Wars.[46]

U.S. naval aviation responded to the dual threats of Soviet submarines and bombers with a dual developmental program of its own: (1) development of long-range patrol aircraft and anti-submarine warfare (ASW) doctrine to counter the submarine threat and (2) modernization of the Navy's carrier-based jet inventory to counter the long-range bomber threat. The anti-submarine developments centered on the introduction of new patrol aircraft, taking advantage of new airborne electronic detection technologies, and operating from land bases. The anti-bomber initiative centered around advances in aircraft and weapons technologies, and advances in aircraft carrier design and operations.[47]

One of the key lessons drawn from the Korean War was the need for carrier aircraft to be able to fight effectively against land-based jets over enemy shores. The Korean War had witnessed the first use of jet aircraft operating off carrier decks (although they were supplemented by a great number of World War II-vintage propeller-driven aircraft as well). Throughout the period, the Navy concentrated on updating its jets and modernizing weaponry, including the introduction of faster, longer-ranged, and more reliable aircraft, air-to-air missiles, G-suits and ejection seats, improved avionics, navigational gear, and electronic sighting. In addition, the use of carrier-based helicopters on search and rescue (SAR) missions during the Korean War was expanded upon, with helicopters eventually replacing floatplanes on battleships and cruisers and assuming new missions such as gunnery spotting, mine sweeping, and ASW operations. To supplement the jets which were increasingly dominating the combat aircraft inventory, the Navy also fielded a number of propeller-driven attack and early-warning aircraft. Like the Navy, the Marine Corps' air arm began to adopt jets for its close air support roles. The Marines also adopted the helicopter for its evolving vertical assault doctrine. This doctrine called for the use of airborne

Marine infantry forces to be inserted by helicopter behind enemy forces, harassing the defenders and cutting off retreat from the main amphibious assault.

Parallel developments to those in aircraft technology also followed in carrier design with the 1953 christening of the *USS Antietam*. This was the Navy's first carrier to be equipped with an angled flight deck and steam catapults in order to better accommodate the higher speeds and weights of the new jet aircraft. The *Antietam* was followed in 1955 by the first of the Navy's supercarriers, the *USS Forrestal*, to be followed rapidly by its sister ships, the *Saratoga*, *Ranger*, and *Independence*. These huge vessels were twice the size of the World War II-era *Essex*-class carriers, and their angled flight decks and cavernous hangar decks could accommodate more than 100 aircraft of various types. In 1961, the Navy launched the *USS Eisenhower*, the first nuclear-powered aircraft carrier. Advances in carrier technology also worked to make carrier operations safer and more efficient, including mirrored and automated landing systems and ground-level ejection seats. In the same year the Navy christened the *USS Iwo Jima* as its first dedicated assault carrier, designed to support the new airborne Marine operations.[48]

During the 1950s and early 1960s the carrier group remained the standard operational formation within the fleet, composed of one or two carriers and numerous frigates, destroyers, cruisers, and auxiliary vessels that protected and supported the carriers. By 1957 the Navy established the standard strength of 15 carrier groups, and this would continue with little variation throughout the Cold War. The primary missions of the carrier groups remained the same: patrolling international waters, showing the flag, and responding to crisis situations. In 1954 and 1955, Pacific Fleet units supported the evacuation of refugees from Vietnam following the Viet Minh victory over French colonial forces, and projected American naval power in the waters between Taiwan and mainland China during tensions there. In 1958, carrier groups supported Marine Corps landings in Lebanon for a peacekeeping mission during a civil war in that country. Perhaps most importantly, the Navy played the key role in maintaining the close blockade of Fidel Castro's island state during the Cuban Missile Crisis of October 1962.[49]

Naval aviation achieved a respectable degree of development during the period, halting the steady decline of the immediate postwar years, recovering its strategic position in the defense establishment, and instituting important technological advances. Nevertheless, relatively little in the way of improvements to naval shore facilities was accomplished in the 1950s and early 1960s. The Navy continued to support most of its air operations using WWII-era facilities, and most bases received only a single new hangar (if any) in the last half of the decade.

There were a few air stations that did receive some new construction, however. Four of these were the four *Master Jet Stations* identified in the 1951 Woods Plan. This plan called for the expansion of four existing air stations to accommodate increased jet aircraft operations. According to the Woods Plan, these stations had to be close enough to major naval bases and population centers to allow for easy logistical support, but isolated enough to allow for safe jet operations and the ability to expand as the ever-increasing speed and performance of new jet aircraft dictated. These four original Master Jet Stations were located at NAS Cecil Field, Miramar, Oceana, and Whidbey Island, near the major stations at Jacksonville, San Diego, Norfolk, and Seattle, respectively. Compared to previous eras, the Master Jet Stations received only a smattering of hangar construction, but it should be noted that this represented a significant percentage of the new naval aviation construction authorized during the late 1950s. Specifically, Cecil Field received one hangar, Miramar and Whidbey Island each received two, and Oceana received three during the last half of the decade.[50]

Another installation receiving relatively intensive construction during this period was NAWS Point Mugu, which received six hangars between 1950 and 1960 as it continued to expand in response to the increasing tempo of naval aviation technology research.[51]

Finally, the Marine Corps received a new air station at MCAS Beaufort, SC, featuring three new hangars erected in 1956 and a fourth in 1959. This new station was established to support the Marine Corps' transition from propeller-driven to jet-propelled aircraft to match those of the Navy.[52]

Thus, while the primary driver of Navy aviation technical construction during the 1950s appears to have been the adoption of jet aircraft, relatively few new hangars projects seem to have come of it. The other nominal spur to new construction — long-range patrol operations — appears to have produced even fewer new hangars because these operations were dispersed among a large number of tenant bases. Again, this development produced only one new hanger, if any, at the affected bases. Even the more substantial technical aviation construction programs (i.e., the Master Jet Stations, Point Mugu, and Beaufort) appear small when compared to various concentrated building programs that dominated in previous decades. Most received only a single new structure, and even the greatest expansion of operational facilities (MCAS Beaufort) included only four hangars. Generally speaking, the Navy continued to operate its aviation program from existing facilities — a trend that would continue throughout the rest of the Cold War.

Another trend that was reinforced during this period, dating back to WWI, was the dominance of a small number of standard designs in the few new construction projects that the Navy did undertake. During the 1950s, however, this approach did change to some extent. Although two standard designs do appear to comprise a sizable percentage of the new construction projects, they are not nearly as prevalent as some of the dominant designs in earlier periods — most notably the standard B-M hangar types of the WWII era. The two dominant standard designs of the period were the Denver Type Reserve Station Hangar and the Miramar Hangar. The Denver Type Reserve Station Hangar is found on Bureau of Yards and Docks definitive drawings 486581–486639, 520115, and 520026–520032. This structure has an overall usable width of 240 ft and a clear span of 150 ft. The arched hangar bay is flanked on both sides by office, shop, and storage spaces. The Miramar Hangar features two 150 x 240 ft arched hangar bays separated by a 120 x 240 ft open shop area. Second-story offices line the perimeter of the central shop area and the outside lengths of the hangar bays (Figure 5-12). However, while a number of these hangars were constructed in singles and pairs at various bases such as NAS Pensacola and NAS Miramar, many other bases continued to employ older standard types in order to keep new structures in conformity to older ones, as at NAS Cecil Field.[53]

A third standard design, introduced in the late 1950s, has come to dominate naval aviation technical construction efforts to a degree more typical of earlier construction campaigns. This modular hangar design was developed in order to allow a great degree of flexibility in responding to basing needs. The unique structural solution provided by this modular design appears to be based on various wharf structures and cranes. The main structural members of a cantilever system are exposed on the exterior, making the hangar type easy to discern.* A series of bays or modules, marked by this repeated external structure, can be constructed and extended later as needed. The E-Module type appears to be of steel girder construction with a bay height of 35 ft (Figure 5-13). Two variations adopted by the Navy, the Type I and Type II, have 28 ft and 42 ft bay heights, respectively (Figures 5-14 and 5-15). The former is 110 x 96 ft and designed to house carrier aircraft. The latter measures 115 x 120 ft and houses patrol aircraft. Both of these later types may feature either girder or truss steel components. The first examples of these external-structure types appear to have been

* Having the structural elements exposed on the exterior of this hangar type has proved troublesome. Maintenance problems are evident in regions where the interior-exterior temperature differential is extreme. Structural components on the inside of the hangars expand and contract at a different rate than those on the outside.

erected at MCAS Beaufort in 1956, and the type has comprised a majority of all technical construction undertaken in support of Naval aviation throughout the decades since. A new Marine Corps Air Station — MCAS Yuma — was established in 1959, and a new Master Jet Station was established in 1961 at NAS Lemoore. Each station received hangars of the new standard designs, with Yuma receiving four of the E-Module hangars and Lemoore receiving five. The plans continue as a viable alternative even today, with the latest identified example having been erected at NAS North Island, CA, in 1993.[54]

### Vietnam and the 1970s

In early August 1964, North Vietnamese patrol torpedo (PT) boats attacked and damaged a U.S. destroyer in the Gulf of Tonkin. President Johnson ordered elements of the Navy's air arm to conduct immediate retaliatory air strikes against PT boat bases in North Vietnam. This action constituted the opening phase of the Vietnam conflict for naval aviation, beginning operations against the North Vietnamese that would last through 1972. Throughout the conflict, the Navy maintained a close blockade of the Vietnamese coast, conducted a riverine campaign with South Vietnam's fledgling, brown-water Navy, provided naval gunfire support along the southern coast, and conducted a large-scale air offensive throughout Vietnam in support of U.S. and allied ground forces. This air offensive involved a constant campaign of close air support missions conducted by Navy and Marine Corps aircraft operating from the four to five carriers that maintained positions off the Vietnamese coast. It also involved two distinct interdiction air campaigns in North Vietnam, from 1965 – 1968, and again from 1969 – 1971. Tight rules of engagement and strictly limited target lists hampered the efforts of naval aviators, and the improving North Vietnamese air defense system eventually cost the Navy and Marine Corps air arms more than 500 men throughout the conflict. Navy and Marine Corps aviators flew the bulk of their CAS and interdiction missions in the new A-4 Skyhawk and F-8 Crusader II, with a sizable contingent of Skyraiders continuing to serve as well — especially in CAS roles. The new F-4 Phantom II played the primary fighter role, and Navy fliers experienced the same problems that Air Force pilots did with this aircraft, including limited dogfighting capabilities and a heavy reliance on air-to-air missiles. In the closing stages of the war, the Navy also introduced the new A-6 Intruder as its premier attack platform, a role it continues to play today.[55]

The Vietnam conflict was not the Navy's only concern in the 1960s and 1970s, of course. The Soviet Union continued to expand its own naval forces, including the introduction of its first small carrier employing vertical/short takeoff and landing (V/STOL) aircraft in the mid-1970s. The Navy's ability to expand with

the Soviets was limited by the great expense of its operations in Southeast Asia, and even before the United States withdrawal from Vietnam, the Navy actually experienced some downsizing. From a peak of 769 combat vessels in the late 1960s, the Navy's fleet strength dropped to only 512 ships by 1972. Moreover, lack of funding and public support brought readiness to a low point in the late 1970s. The reduced funding support forced a contraction in the aircraft inventory as well, and the Navy was forced to make the most of its limited strength by modernizing its air arm. The lessons learned during the Vietnam conflict, combined with continuing improvements in the Soviet attack bomber inventory, induced the Navy to adopt a new front-line fleet interceptor aircraft. The new F-14 Tomcat was introduced in this role in 1974, and it remains the premier fleet defense fighter in the world today. The S-3 Viking airborne early warning aircraft was introduced about the same time and also continues to serve in that function. The continued development of Marine Corps vertical envelopment doctrine and the crucial role played by air mobility in Vietnam continued to emphasize the importance of helicopter operations, and the Navy christened the first of its new Tarawa-class assault carriers in 1976. The Navy also updated its organizational structure by replacing its traditional bureau system with the system of naval commands that it employs today. The duties of the old Bureau of Yards and Docks were assumed by the new Naval Facilities Engineering Command (NAVFAC), which continues to oversee the maintenance and construction of the Navy's shore infrastructure.[56]

Given the restricted funding environment of the period it should not be surprising that relatively little was accomplished toward updating the Navy's aviation shore facilities. Throughout the late 1960s and the 1970s, no air station received more than three new hangars, and most received only one or two. Moreover, at no base were any two of these hangars constructed in the same year. There is no indication of a concerted construction campaign at any of the Navy's air stations. Instead, a slow, steady scattering of new facilities occurred across the entire range of bases. As in the pre-Vietnam era, new construction continued to be dominated by the standard modular, external-structure Navy designs, although this dominance was not so pronounced as had during pre-Cold War periods. MCAS Yuma, NAS Kingsville, NAS Lemoore, NAS Miramar, NAS North Island, and NAWS Point Mugu all received one or two examples of these standard types. Some stations, such as NAS Cecil Field and NAS Jacksonville continued to confine their new hangars to the popular types already existing on base.[57]

### The End of the Cold War

The national defense policies of the Reagan Administration throughout the 1980s brought a degree of recovery to naval aviation somewhat parallel to that

experienced under Eisenhower in the 1950s. Increased budgetary support allowed for the expansion of the fleet back toward the 600-vessel mark, maintaining the standard operational force of 15 carrier groups. This expansion was supplemented by the reactivation of a number of heavily refitted WWII-era battleships and continued growth in the Navy's complement of the new AEGIS cruisers and destroyers, which provided unparalleled anti-aircraft and anti-missile defense capabilities. The Navy's carrier groups continued to provide rapid response to crisis situations around the globe, including actions against Libya in the Gulf of Sidra in 1981 and Operation El Dorado in 1986, support of the Marine Corps peacekeeping mission in Lebanon in 1983, and prominent participation in the tri-service invasion of Grenada in 1983. Perhaps most importantly, and certainly most visibly, naval aviation played a large role in operations DESERT SHIELD and DESERT STORM in the Persian Gulf in 1991. Especially in this latter conflict, the Navy's and Marine Corps' new F/A-18 Hornet fighter-bombers proved themselves capable replacements for the aging Crusader and Phantom II models that they had begun replacing in the early 1980s. The Marines' Harrier II V/STOL jets also turned in a fine performance in CAS roles over the sands of Iraq during this conflict.[58]

Yet, as was the case in the earlier Cold War periods discussed above, relatively little in the way of new aviation technical construction was necessary to support this new expansion. As before, few bases received more than one or two new hangars, but some exceptions can be found. The Marine Corps' air facilities at Camp Pendleton, CA, for example, received three new hangars during the 1980s, as did NAS Fallon and NAS North Island. NAS Whidbey Island received five new hangars during the decade. As was found to be the case in earlier Cold War periods, many of these hangars continued to be constructed according to standard Navy modular designs, but the use of these plans is not as dominant as it was in earlier years. Examples in the 1980s appear at NAS Mayport, NAS North Island, and NAWS Point Mugu. More of the new hangars appear to have been constructed from new Navy-approved designs, some to match the existing structures on their respective bases, as at NAS Atlanta and NAS Fallon.[59]

### *Summary of Cold War Naval Aviation Construction Activity*

In general, new aviation technical construction for the Navy's air arm during the Cold War appears not to have followed the standard pattern of distinctive, massive building campaigns dominated by a small number of standard designs that is characteristic of earlier periods. Rather, the Navy received a smattering of new construction dispersed over the entire aviation shore establishment in small increments — usually only a single structure and, with one exception, never more than two in a single year at a single base. The sole exception to this rule

was the erection of five new hangars at NAS Lemoore in 1961, associated with its initial commissioning.

While the majority of new Navy hangars built during the Cold War era did conform to one of the three major standard designs of the period — particularly the modular designs with the distinctive exposed structural elements — a large minority were instead constructed from a variety of other designs, often apparently to ensure that new structures resembled hangars already existing on base.

The conversion of the Navy's air arm to an all-jet inventory in the mid-1950s, as well as the proliferation of long-range, land-based patrol aircraft during the same period, spurred some of the new hangar construction. However, most of the Navy's aviation basing needs continued to be met by WWII-era facilities, or were met by slowly augmenting existing facilities with a small number of new hangars as the need arose. It seems clear that this pattern will continue in the near future, as base realignment and closure initiatives create new requirements at consolidation bases.

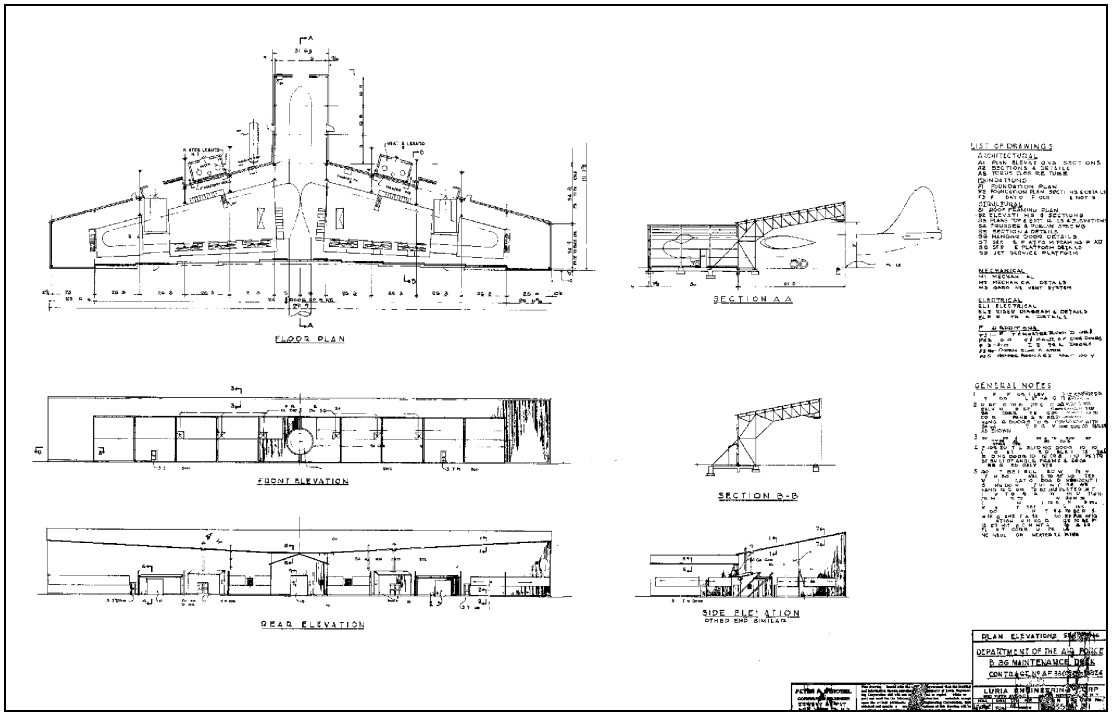


**Figure 5-1. Example of the 39-05 hangar plan series to house B-36 aircraft at Ellsworth Air Force Base, SD.**

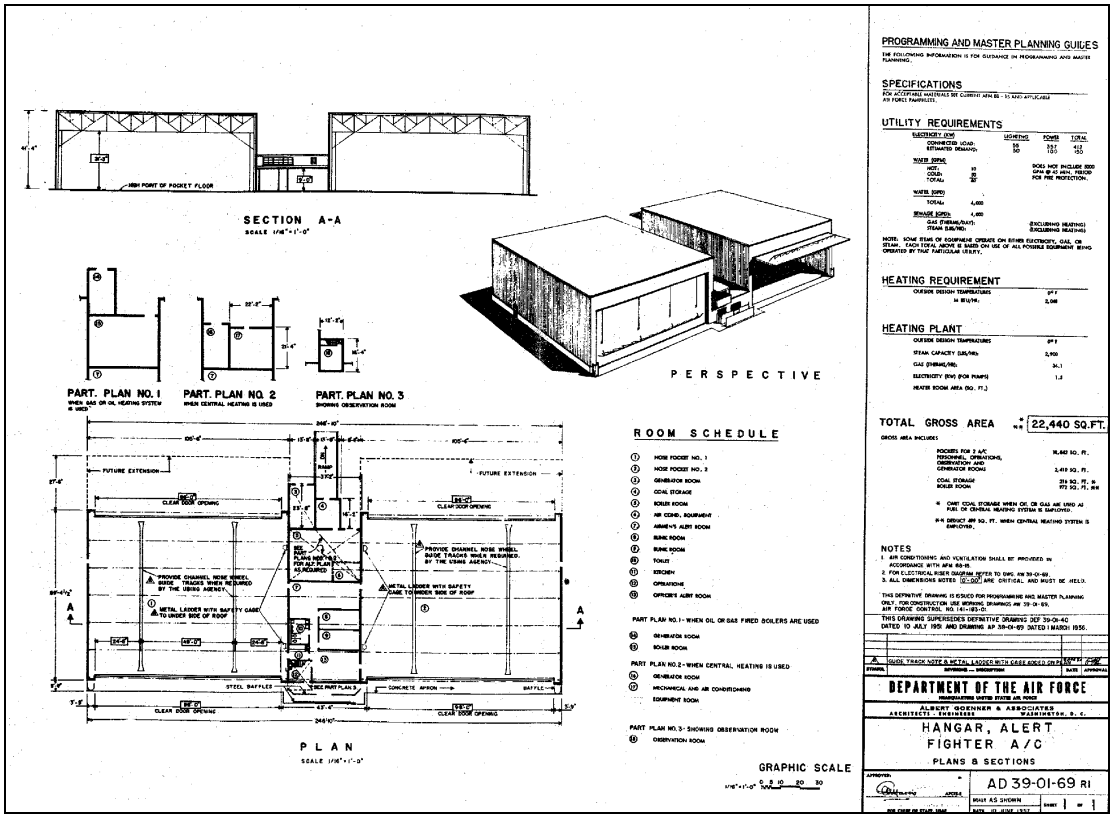


**Figure 5-2. Plan No. 39-01-69, Hangar - Alert Fighter Aircraft.**

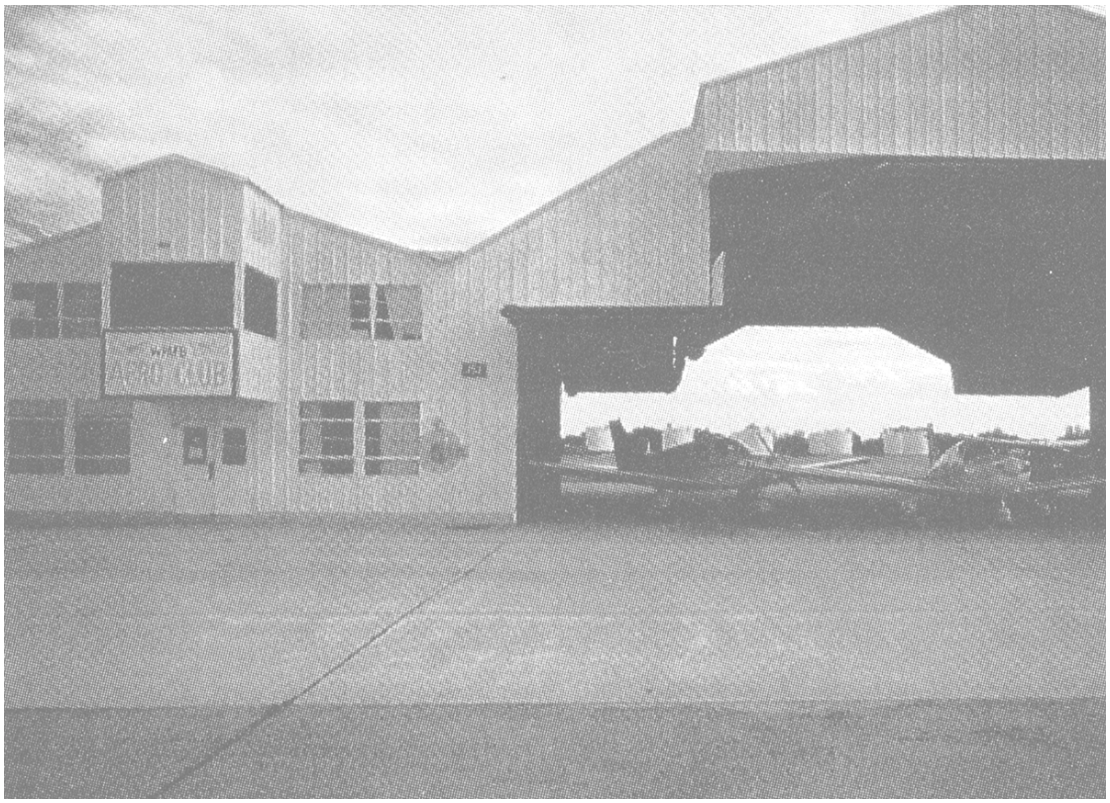

**Figure 5-3. Example of a prefabricated alert hangar at Wright-Patterson Air Force Base, OH, ca. 1952.**

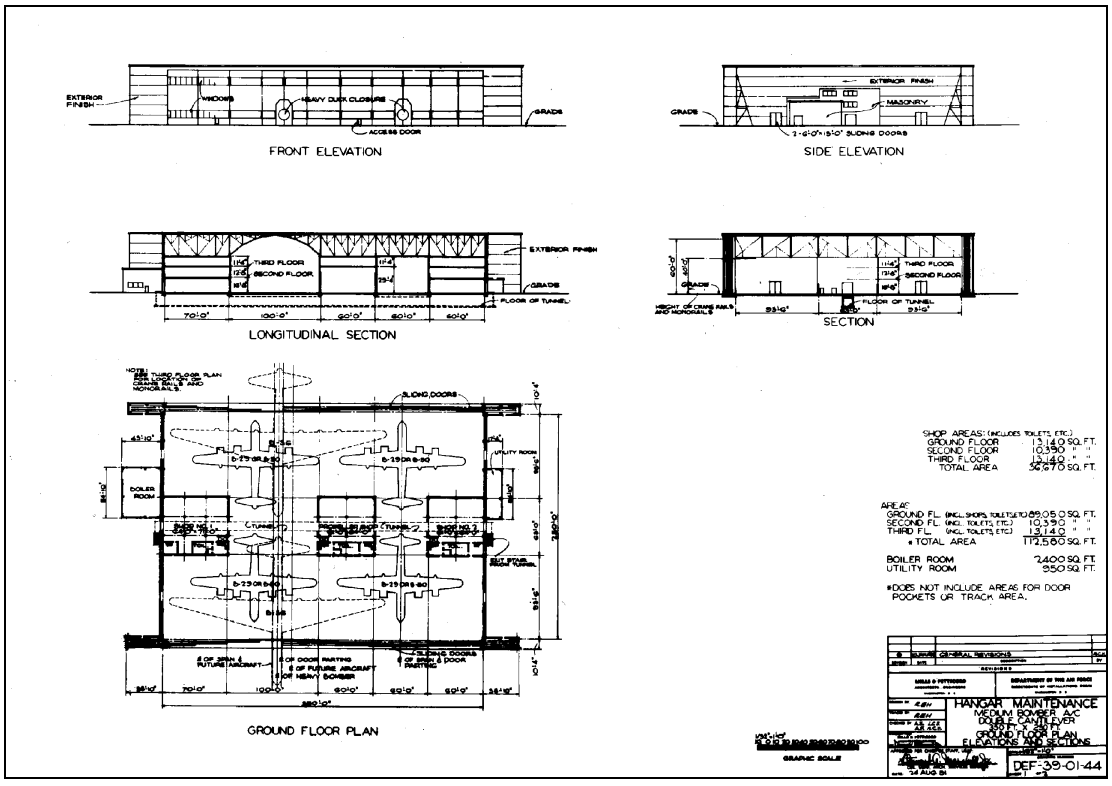


**Figure 5-4. Plan No. 39-01-44, Hangar - Maintenance, Medium Bomber Aircraft.**

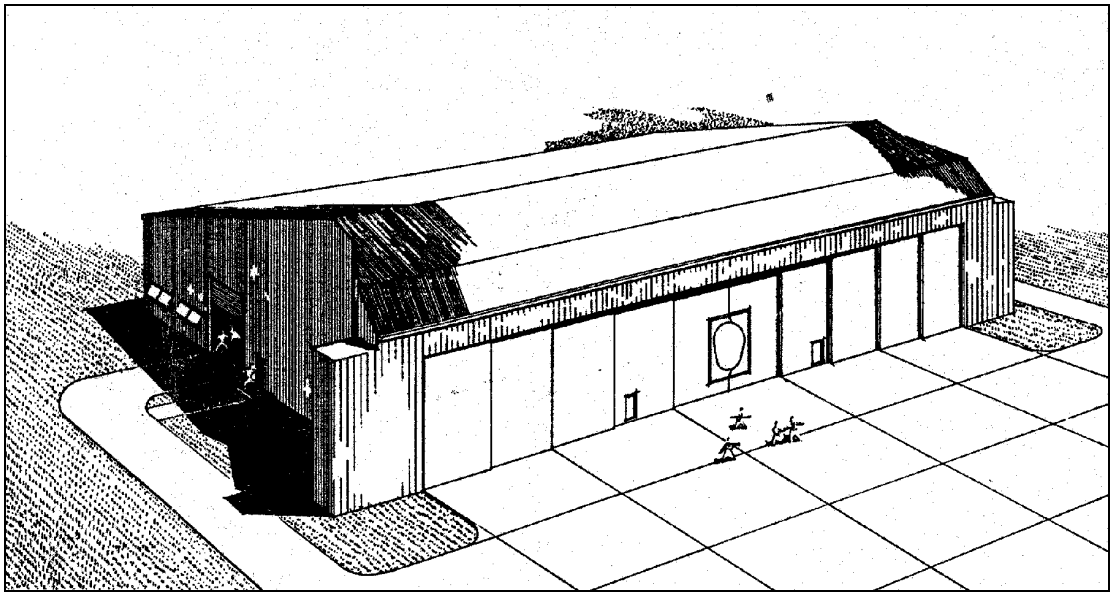

**Figure 5-5. Perspective drawing of a SAC Dispersal Maintenance Hangar.**

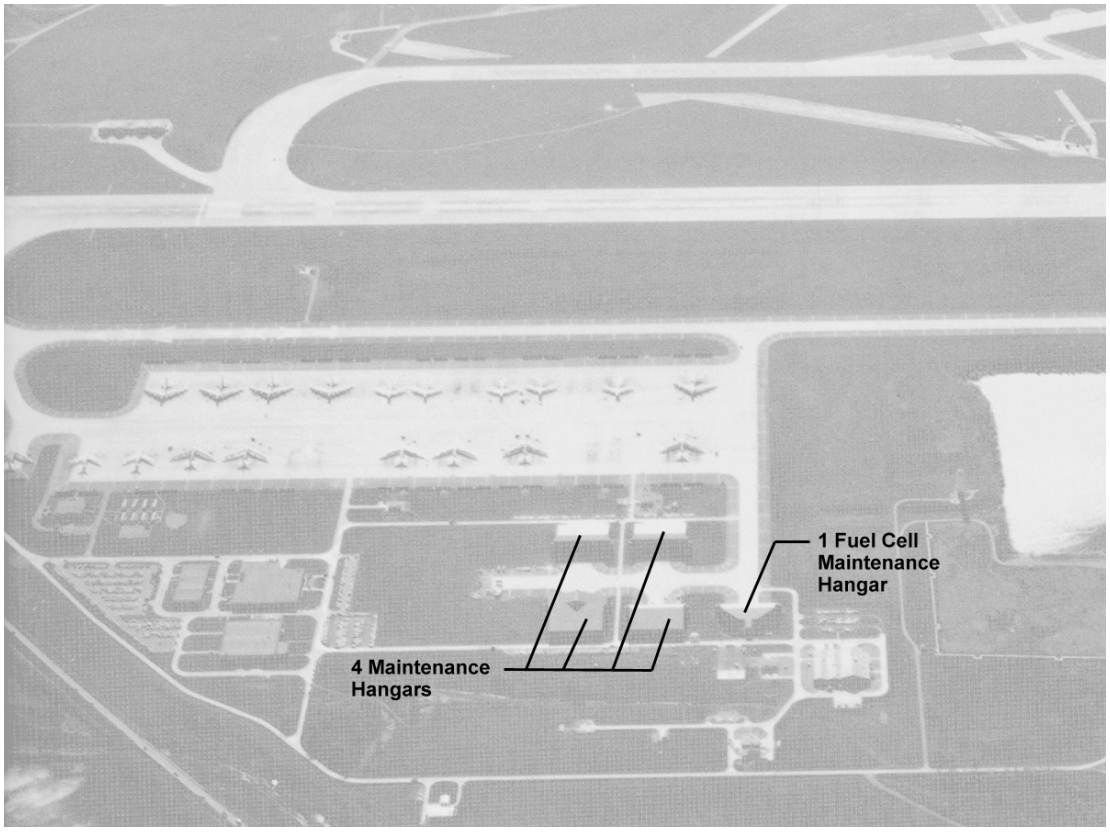


**Figure 5-6. Typical SAC Dispersal layout.**

**Figure 5-7. SAC Dispersal Fuel Cell Maintenance Hangar at Wright-Patterson Air Force Base, OH, ca. 1959.**

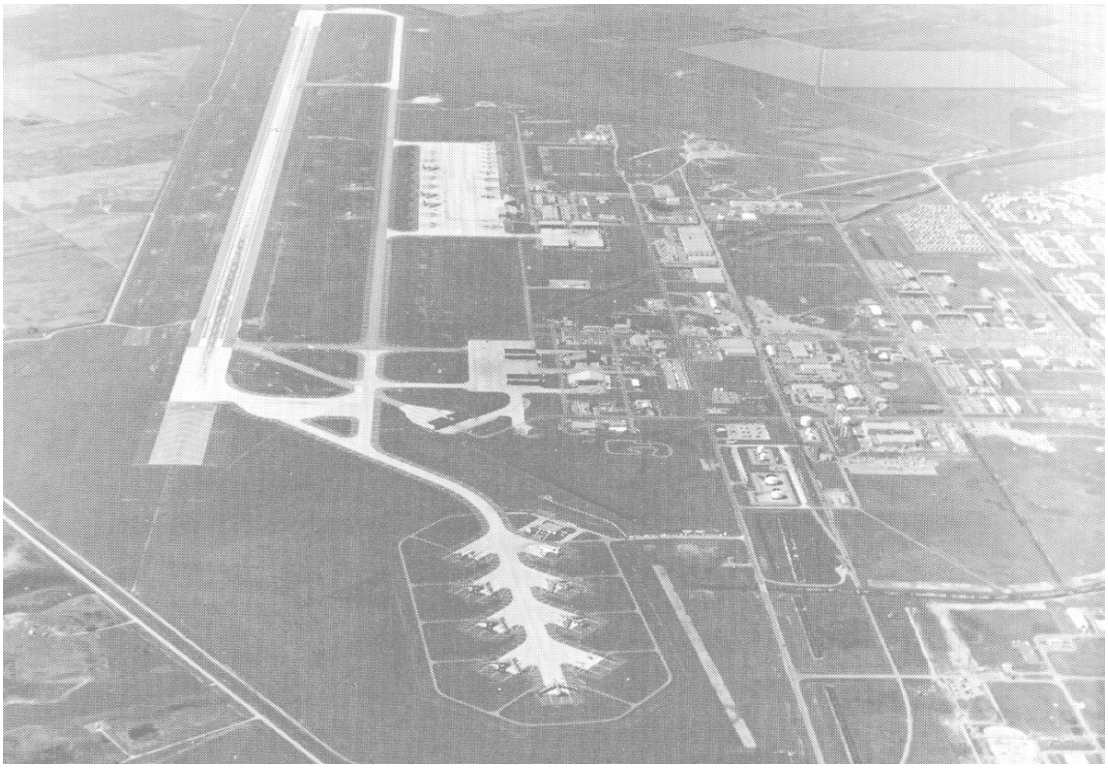

**Figure 5-8. Typical SAC Dispersal layout featuring five ramps arranged in a herringbone pattern at Minot Air Force Base, ND.**

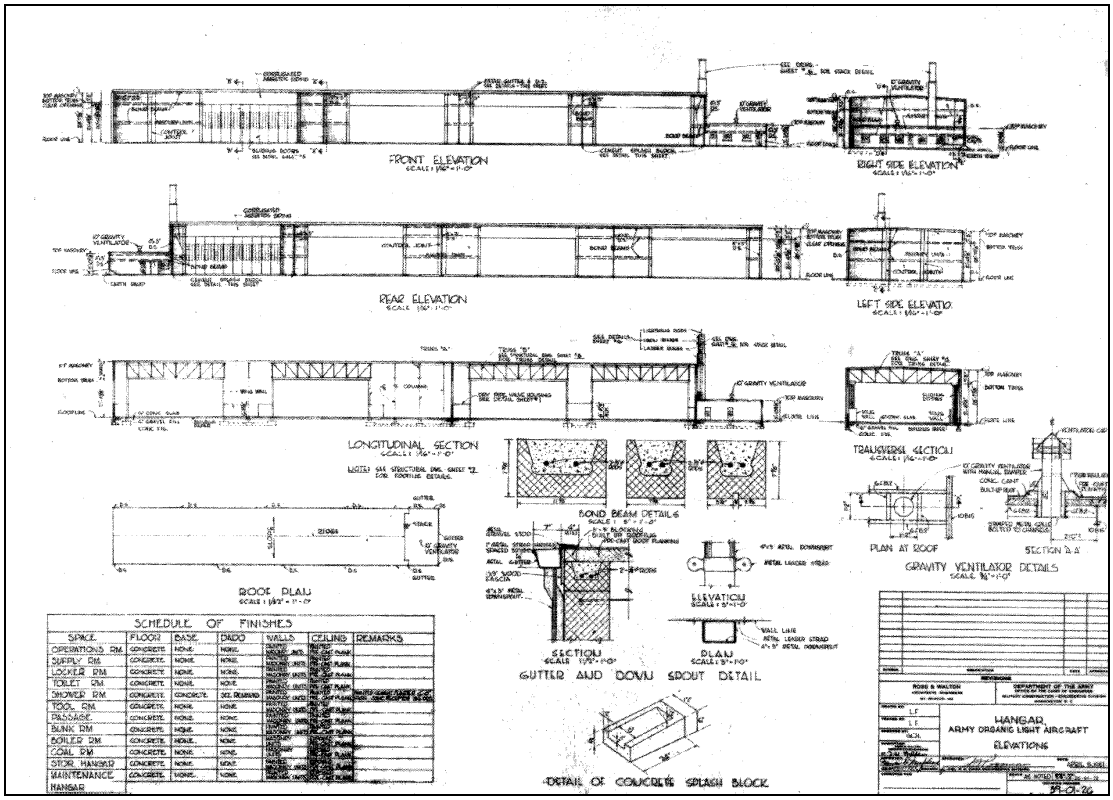


**Figure 5-9. Plan No. 39-01-26, Hangar - Army Organic Light Aircraft.**

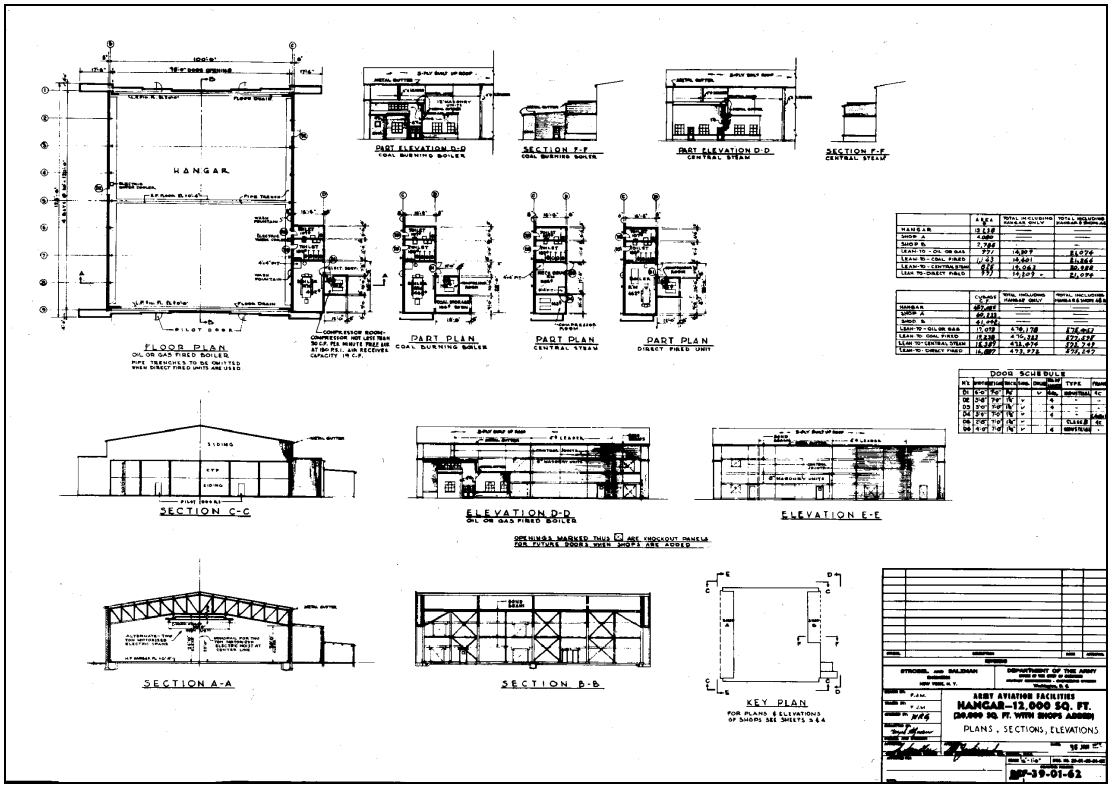


**Figure 5-10. Plan No. 39-01-62, Hangar - 12,000 Sq Ft (20,000 Sq Ft with Shops Added).**

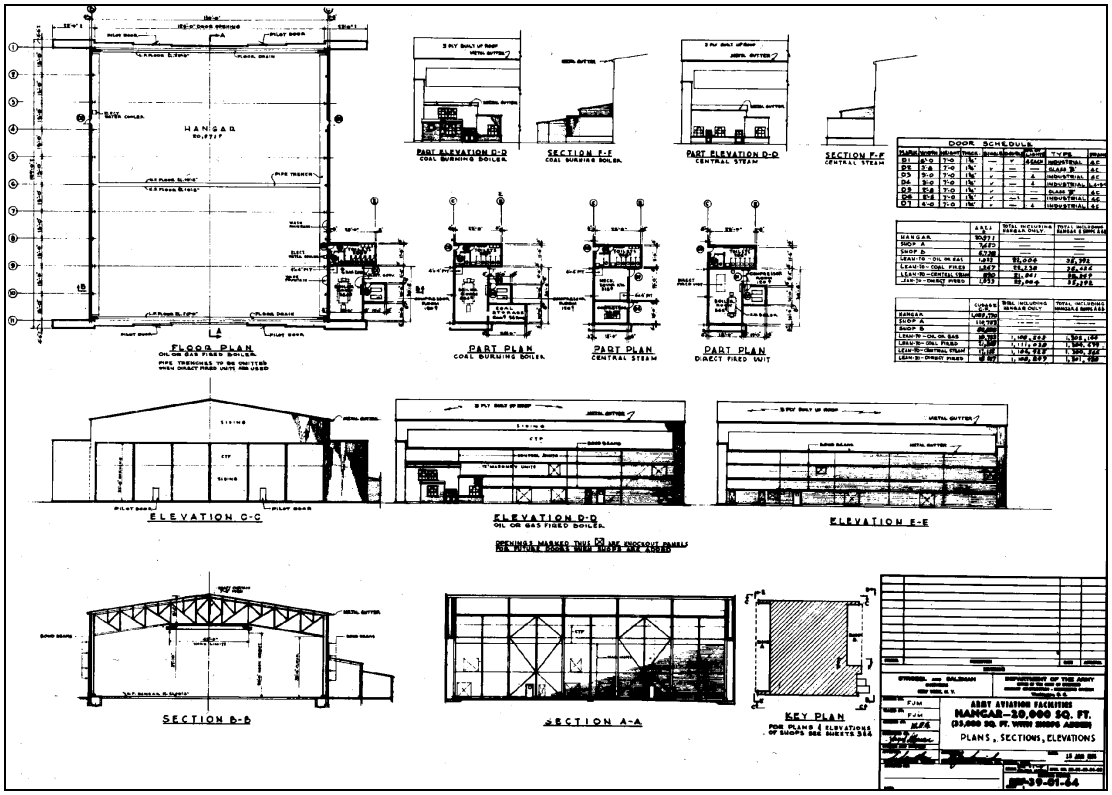


**Figure 5-11. Plan No. 39-01-64, Hangar - 20,000 Sq Ft (35,000 Sq Ft with Shops Added).**

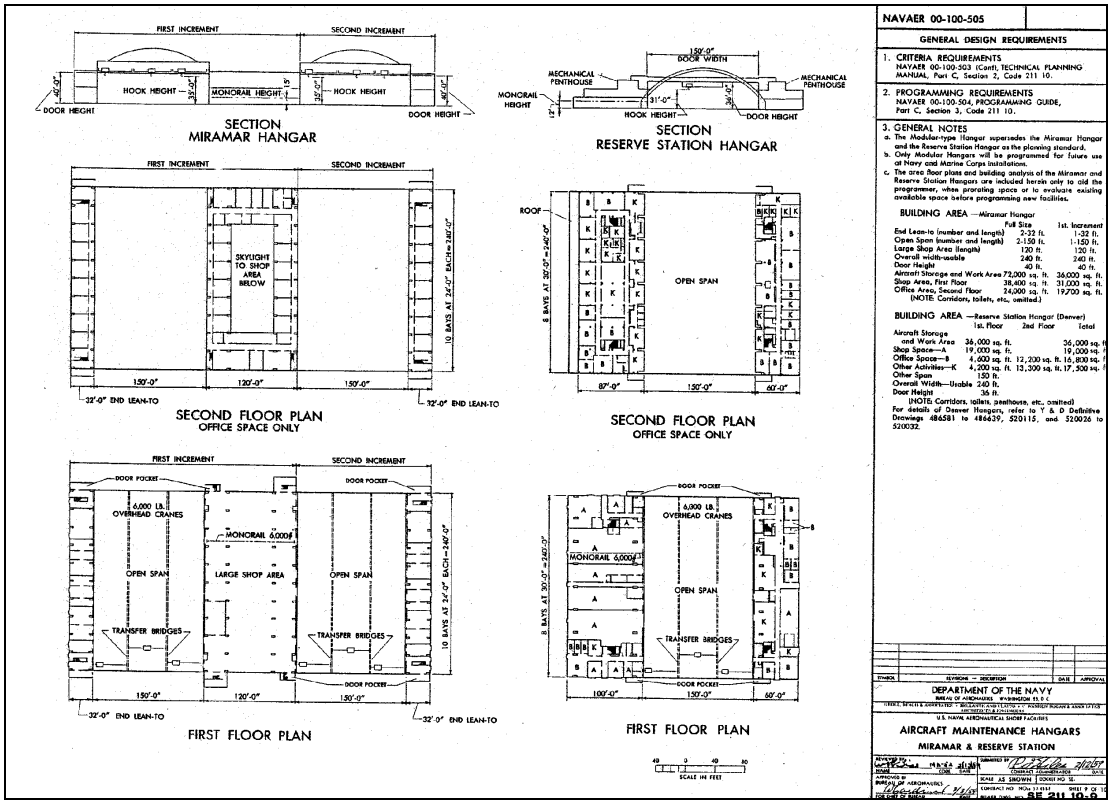


**Figure 5-12. Plans for the Miramar and Reserve Station Hangars.**

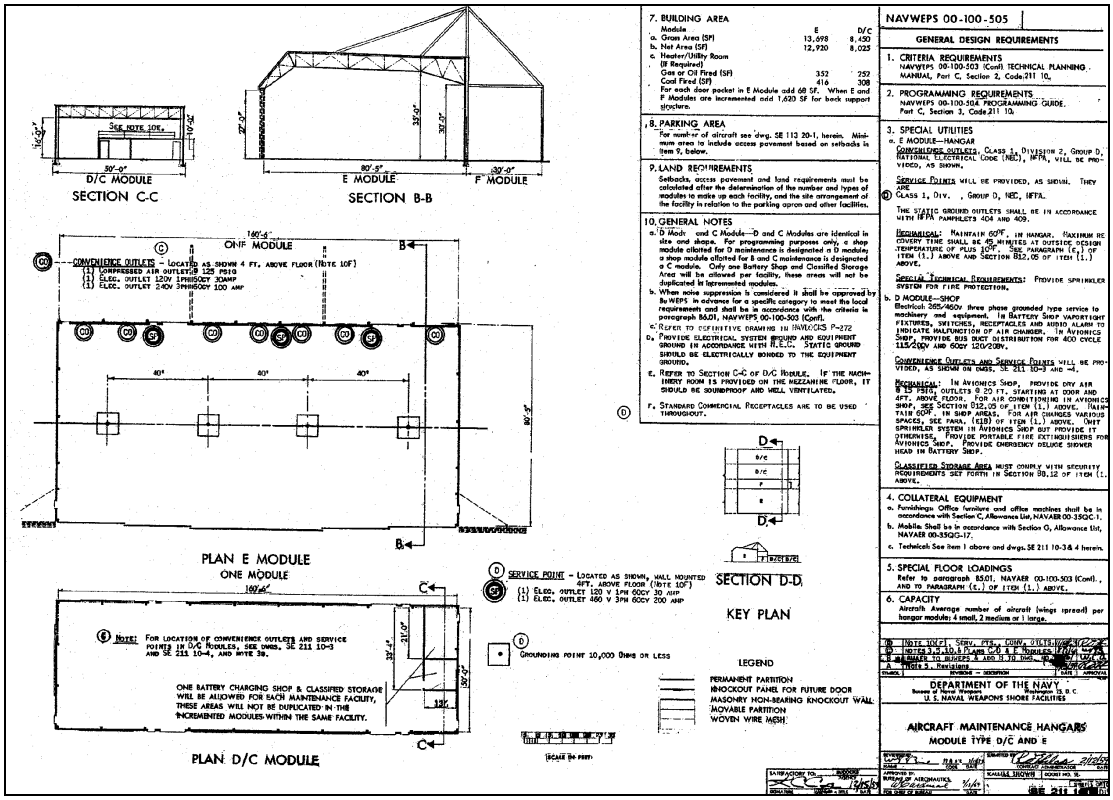


**Figure 5-13. Plan for the Modular Hangar.**

**Figure 5-14. NAVFAC Type Maintenance Hangar at NAS Pensacola, FL, ca. 1965.**

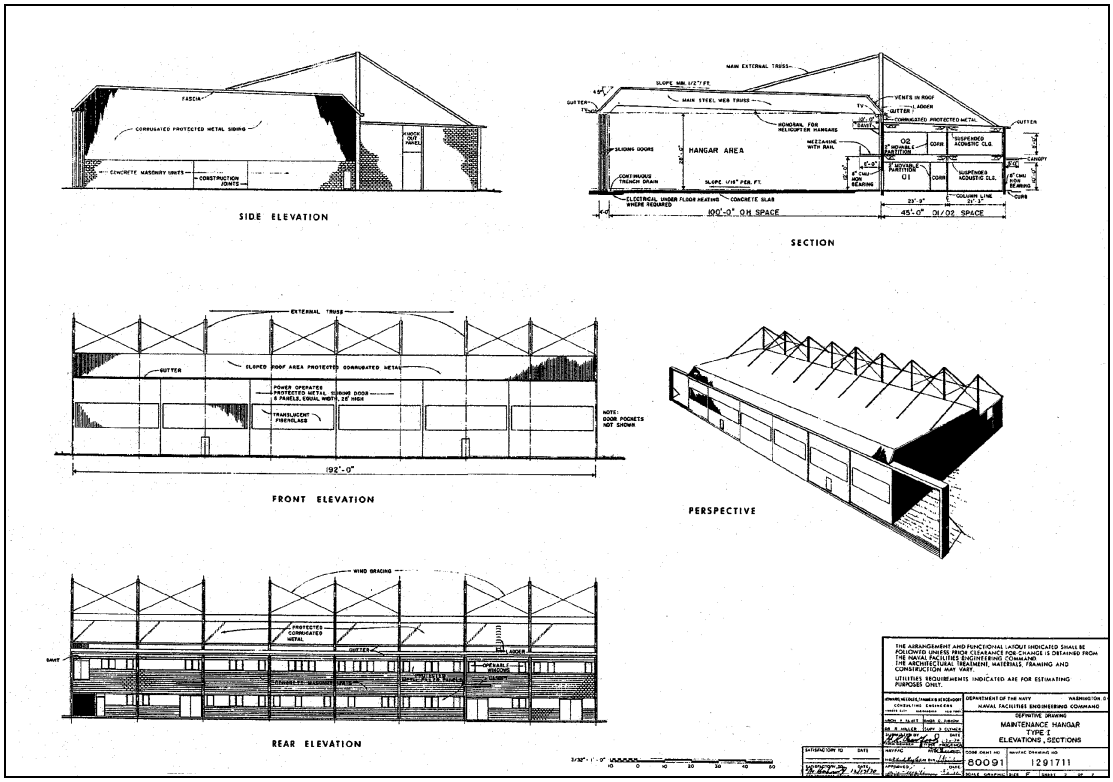


**Figure 5-15. Plan for the NAVFAC Type II Maintenance Hangar.**

## Endnotes for Chapter 5

1 Anderton, pp 132, 134; Boyne, pp 180-183; Yenne, pp 42, 44; Futrell, pp 205, 219.

2 Yenne, pp 26, 38-42; Anderton, pp 133-135; Boyne, p 184; Futrell, pp 201-208.

3 Richard I. Wolf, *The United States Air Force*: *Basic Documents on Roles and Missions* (Washington, DC: Office of Air Force History, USAF, 1987), pp 151-166; Futrell, pp 196-201, 237-259; Yenne, p 157.

4 Anderton, pp 137-140; Boyne, pp 185-188; Futrell, pp 235-236.

5 Futrell, pp.345-351; Wolf, pp 237-245.

6 Futrell, pp 304, 419-433.

7 Futrell, pp 282-334; Boyne, p 202; Yenne, pp 159-163.

8 Anderton, pp 157-163; Futrell, pp 523-540; Yenne, pp 30-135.

9 Futrell, p 477.

10 Futrell, pp 452-467; Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1907-1960*, Vol. II (Maxwell AFB, AL: Air University Press, 1989), pp 24-25, 39-43. Hereinafter cited as "Futrell II."

11 Anderton, pp 167-208; Boyne, pp 219-259; Yenne, pp 58-101.

12 Anderton, pp 213-221; Boyne, pp 280-282; Yenne, pp 140-144.

13 Boyne, pp 270-275, 282-289.

14 Boyne, pp 291-296; Yenne, p 168; *Gulf War Air Power Survey, Vol. IV: Weapons, Tactics, and Training and Space Operations* (Washington, DC: U.S. Government Printing Office, 1993), pp 39-41, 243-247; Anderton, pp 261-265.

15 Gulf War Air Power Survey, passim. but see Volume V: Summary Report; Anderton, pp 221-224; Yenne, pp 189-191.

16 Boyne, pp 319-321.

17 Butterworth, pp 65-66; Currey, pp 42-44.

18 Currey, pp 52-56.

19 Butterworth, pp 74-76; Currey, pp 57-59.

20 Butterworth, pp 76-82; Currey, pp 59-63.

21 Butterworth, p 79; Currey, pp 83-84.

22 Currey, pp 44-46.

23 Currey, p 63.

24 Butterworth, pp 81-82; Currey, pp 57-64.

25 Butterworth, pp 84-88.

26 Butterworth, pp 76-77.

27 Currey, p 57.

28 Butterworth, pp 88-90; Currey, pp 70-72.

29 Currey, pp 67-68.

30 Currey, pp 76-78.

31 Butterworth, pp 94-97; Currey, pp 78-81.

32 Currey, pp 72-77.

33 Butterworth, pp 101-112.

34 Butterworth, p 97; Currey, pp 81-86.

35 Swafford Johnson, *The History of the U.S. Cavalry* (Greenwich: Bison Books, 1985), p 186.

36 Currey, pp 198-199; Russell F. Weigley, *History of the United States Army*, Enlarged Edition (Bloomington: Indiana University Press, 1984), pp 573-583.

37 Bradin, pp 125-126.

38 Bradin, p 131.

39 Bradin, pp 135-139.

40 Bradin, pp 140-156.

41 Currey, pp 191-192.

42 Goodwin and Associates, *Navy Cold War Guided Missile Context* (1995), pp 18-19.

43 Goodwin and Associates, p 19.

44 Real Property Records, NAWS Point Mugu.

45 Goodwin and Associates, pp 19-20.

46 Goodwin and Associates, p 20.

47 Goodwin and Associates, p 19.

48 Goodwin and Associates, p 20.

49 Ibid., pp 21, 24.

50 Real Property Records supplied by NAS Cecil Field, NAS Miramar, NAS Oceana, and NAS Whidbey Island.

51 Real Property Records supplied by NAWS Point Mugu.

52 Real Property Records supplied by MCAS Beaufort.

53 Real Property Records supplied by NAS Pensacola and NAS Miramar; Navy Drawings on Film Collection, NARA Archives II.

54 Real Property Records supplied by MCAS Beaufort, MCAS Yuma, NAS Lemoore, NAS North Island; Navy Drawings on Film Collection, NARA Archives II.

55 Goodwin and Associates, p 24.

56 Ibid., pp 25-27.

57 Real Property Records supplied by MCAS Yuma, NAS Kingsville, NAS Lemoore, NAS Miramar, NAS North Island, and NAWS Point Mugu, NAS Cecil Field, NAS Jacksonville.

58 Goodwin and Associates, pp 26-28.

59 Real Property Records supplied by MCB Camp Pendleton, NAS Fallon, NAS North Island, NAS Whidbey Island, NAS Mayport, NAWS Point Mugu, NAS Atlanta, NAS Fallon.